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CONTENTS

No. 1, January, 1940

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No. 2, February, 1940

[Issued February 20, 1940.]

No. 3, March, 1940

[Issued April 3, 1940.]

No. 4, April, 1940

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RICE AS A SUBSTITUTE CEREAL IN THE MANUFACTURE OF SOY SAUCE

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and

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Soy sauce is a salty liquid of dark-brown color made by fermentation of soy beans and a starchy component.

Recently we carried out experiments on the manufacture of soy sauce and found that rice could be used successfully as the starchy material necessary for making the sauce.

Soy sauce is widely used as a condiment in Japan, China, Java, the Philippines, and other countries. It is the base of the well-known Worchestershire sauce.

The Chinese method of soy-sauce manufacture [1] is used in the Philippines. The beans are soaked in water, cooked, drained, and mixed with flour. The mixture is spread on trays and left exposed for the spontaneous growth of molds. *Aspergillus niger* and *Aspergillus oryzae* usually grow together in this mixture. After the molds have grown for about a week, the whole mass is placed in 25 per cent salt solution contained in earthen jars and exposed to the sun for 2 to 3 months. The first drawings are made after this period.

The Japanese use roasted barley or roasted whole wheat instead of flour in making soy sauce.

[1] Groff, E. H., Philip. Journ. Sci. 15 (1919) 307.

EXPERIMENTAL PROCEDURE

In our experiments we followed the Japanese method[2] for making soy sauce. Rice being the most abundant cereal in the Philippines, it was tried in place of wheat or barley. The beans (100 parts by weight) were soaked in running water for 24 hours. Continuous change of water is essential to prevent souring of the liquid and the fermentation of the material due to bacteria which are on the beans in the form of spores. The soy beans were cooked in an autoclave until they could be easily crushed between the fingers. They were then drained and allowed to cool. The rice (70 parts by weight) was roasted to a brown color, reduced to a coarse powder, allowed to cool, and inoculated with spores of *Aspergillus oryzae*. The inoculated rice powder was mixed with the beans so that every bean was coated with it. The mixture was placed in shallow trays and piled about 3 centimeters deep. At the end of about 18 hours it was stirred to break up the beans that were bound together by the mycelia of the mold. Heat is generated during the fermentation, and thorough stirring is necessary to aërate and cool the mixture. Since the presence of moisture and the lack of oxygen favor the development of mucors and bacteria which are detrimental to the flavor of the sauce, excessive heat should be avoided because this condition increases moisture condensation.

The mass was left undisturbed for a period of 7 hours, then stirred a second time. Again the mixture was incubated for 12 to 14 hours, after which it became coated with the yellow spores of the mold. It was allowed to mature for another 24 to 30 hours. At the end of this period the mass, which could be lifted as an entire block, was disintegrated and transferred into brine (95 parts salt by weight in 180 parts water by volume).

For every 4 liters of the resulting mixture, 10 grams of yeast was added and allowed to ferment for 3 months with occasional stirring. The sauce was extracted by pressing the mass and filtering the liquid.

RESULTS

After a fermentation period of one month the sauce was found to contain 5.3 per cent protein by analysis. At the end of 3 months the protein was 7.5 per cent.

[2] Church, Margaret B. U. S. Dept. of Agriculture. Dept. Bull. No. 1152 (1923) 1.

The sauce obtained was a very dark-brown clear liquid. Its taste and flavor was similar to that of the best quality of Japanese soy sauce.

The Pure Food and Drugs Act requires a minimum of 4.5 per cent protein for this kind of sauce. One month of fermentation is sufficient to give a product that meets this specification. A new brine may be added to the residue and allowed to ferment for about 2 months to get a second sauce.

SUMMARY

Rice was found to be a good substitute for wheat flour or barley in the manufacture of soy sauce.

Sauce obtained after a month of fermentation contained 5.3 per cent protein, and that after 3 months, 7.5 per cent. These results meet the requirements of the Pure Food and Drugs Act.

The quality of soy sauce prepared by this method compares favorably with the best brands of Japanese soy sauce.

NOTES ON NATURAL DYES FROM IPIL, NARRA, AND TAÑGILE SAWDUST

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Sawdust, found in abundance in lumber mills, is generally used for packing. To find other uses for this byproduct, studies have been conducted on the extraction of its coloring matter for use in the dyeing of cotton, for which synthetic dyes imported from abroad are usually used. The sawdust of ipil (*Intsia bijuga*), tañgile (*Shorea polysperma*), and narra (*Pterocarpus indicus* Willd.) has been included in this investigation. The results are given in this paper.

METHODS OF EXTRACTION

Various methods of extracting the coloring matter from the sawdust of these woods have been tried; among these the following three were selected as the simplest. The coloring matter obtained includes resins and tannic acid.

Method 1.—The sawdust is extracted by boiling under ordinary pressure with a 1 per cent acetic-acid solution for 3 to 4 hours. The decoction is filtered and evaporated to dryness. The extract is ground into a powder.

Method 2.—The sawdust is extracted by boiling with a 1 per cent sodium hydroxide solution under ordinary pressure for 3 to 4 hours. The decoction is filtered and evaporated to dryness. The extract obtained is ground into a powder.

Method 3.—The sawdust is boiled in ordinary water for 5 hours at ordinary pressure. The decoction is then filtered and evaporated to dryness. The extract is ground into a powder form. This method of extraction is the simplest.

All three methods were applied to ipil, narra, and tañgile sawdust. Method 3 was found the most applicable, and hence was adopted in this work. Tañgile sawdust, however, when very dry and old, is better extracted by the use of method 2. From 7 to 12 per cent solid extract, based on the air-dried sawdust, is obtained with these methods.

PROPERTIES OF THE EXTRACT

Ipil sawdust extract.—Ipil sawdust extract is dark brown in the powdered form and reddish-brown in water solution. The addition of hydrochloric acid renders it yellowish brown, and sulphuric acid gelatinous light brown. In an alkaline solution it becomes dark brown.

Narra sawdust extract.—The narra sawdust extract is blackish brown in powdered form and dark yellowish brown in water solution. With hydrochloric acid the color produced is light yellowish brown, and with sulphuric acid it is somewhat darker. The addition of 10 per cent sodium hydroxide solution to its water solution gives it a bluish-green fluorescence.

Tañgile sawdust extract.—In powdered form the tañgile sawdust extract is brown, and in a water solution it is light brown. The addition of hydrochloric or sulphuric acid to the water solution renders it yellowish brown, and the addition of sodium hydroxide, dark brown.

PRELIMINARY TREATMENT OF COTTON

Raw cotton goods contain waxes, serecins, oils, and other impurities, which must be removed before the cotton goods are dyed, if good penetration and level dyeing is to be obtained.

The cotton is scoured or boiled in a bath containing 10 per cent sodium carbonate (2 per cent sodium hydroxide can be used also) on the weight of the material. The goods are worked in this bath for 2 hours or left overnight in the above solution after thorough wetting with water. It is then rinsed well with water and hydroextracted.

METHODS OF DYEING

Different methods of dyeing cotton with the extracts obtained were tried. All of them produced good results, varying only with regard to fastness. The following methods are those that yielded favorable fastness properties.

METHOD 1

Mordanting.[1]—Before being dyed, the scoured cotton is mordanted as follows: The cotton is gradually heated in a bath containing 4 per cent potash alum and 1 per cent sodium

[1] Furry, Margaret S., and Bess M. Viemont, Home Dyeing with Natural Dyes. U. S. Dept. Agr. Misc. Publ. No. 230 (1935).

carbonate (on the weight of the material) and boiled for 1 hour. Then it is cooled and allowed to stand in the bath overnight.

Dyeing.—The mordanted cotton is immersed in a dye bath containing 10 per cent of the sawdust extract (1:20 liquor) and worked for 1 hour at the boiling point. Then 40 per cent sodium chloride (Glauber's salt can be used instead if desired) are gradually added to exhaust the bath, and the material is soaped, rinsed, and hydroextracted.

After treatment.—To improve fastness, the dyed material should be after-treated. Two after treatments were used in this experiment.

(*a*) *After treatment with copper sulphate.*—A warm bath containing 1 per cent copper sulphate is prepared, and the dyed cotton immersed in it and allowed to stand till the bath cools. Then it is rinsed and hydroextracted.

(*b*) *Potassium-dichromate after treatment.*—The dyed cotton is immersed in a warm bath containing 2 per cent potassium dichromate and 1 per cent acetic acid, and worked in the bath till cool. Then it is soaped, rinsed, and hydroextracted.

This method gives a very good fastness to cotton dyed with ipil sawdust extract.

METHOD 2

Mordanting.—Same as in method 1.

Dyeing.—The mordanted goods are placed in a dye bath containing 10 per cent of the sawdust extract, 0.5 per cent potassium dichromate, and 0.1 per cent acetic acid, worked for 1 hour in the bath, and 40 per cent of sodium chloride gradually added to exhaust the bath. Then the material is soaped, rinsed, and hydroextracted.

After treatment.—The dyed material is placed in a warm bath containing 2 per cent copper sulphate and allowed to cool. Then it is soaped, rinsed, and hydroextracted.

Narra-sawdust extract gives a fair fastness to cotton by this method of dyeing.

METHOD 3

Mordanting.—The scoured yarn is placed in a bath containing 1 per cent ferric chloride on the weight of the material for 1 hour at the boiling point. A 1:20 liquor is used.

Dyeing.—The treated yarn is dyed in a dye bath containing 10 per cent of the sawdust extract (more is required for tañgile sawdust extract) and worked for about 1 hour at the boiling point. Then it is soaped, rinsed, and hydroextracted.

After treatment.—The after treatment of the dyed cotton with 1 per cent potassium dichromate is especially adapted to the dyeing of cotton with tañgile-sawdust extract.

The colors obtained from the above methods were different shades of brown. The ipil-sawdust extract gave dark-brown colors, the narra-sawdust extract yellowish-brown or khaki shades, and the tañgile-sawdust extract, light shades of brown, and grayish brown with method 3.

FASTNESS PROPERTIES

The fastness properties of cotton dyed with the extract of ipil, narra, and tañgile sawdust have been tested and found to be fair. The colors will last as long as the material.

Table 1 shows the fastness properties of the dyed cotton. The fastness is graded by the following numbers: 1—excellent, 2—very good, 3—good, 4—moderate, 5—poor.

TABLE 1.—*Fastness properties of cotton dyed with sawdust extracts.*

Manner of dyeing.	Rubbing.	Hot ironing.	Light.	Acetic acid.	Lime water.	Soda boil.	Washing.	Concentrated ammonium hydroxide.	10 per cent sodium carbonate.
Method 1:									
No. 1 ipil [a]	1	1	3	1	2	4	2	2	2
No. 2 ipil [b]	1	1	2	1	2	2	2	2	2
No. 3 ipil [c]	1	1	2	1	2	4	2	2	2
No. 1 narra [a]	1	1	4	2	3	5	5	3	2
No. 2 narra [b]	1	1	2	2	2	5	5	2	2
No. 3 narra [c]	1	1	3	2	3	5	4	3	2
No. 1 tañgile [a]	1	1	3	2	2	2	2	3	2
No. 2 tañgile [b]	1	1	2	2	3	4	3	3	3
No. 3 tañgile [c]	1	1	4	1	2	4	3	2	2
Method 2:									
Ipil	1	1	2	1	3	2	3	2	2
Narra	1	1	2	1	2	3	2	1	3
Tañgile	1	1	2	2	2	2	2	1	3
Method 3:									
Tañgile	1	1	2	1	3	3	2	1	3

[a] Not after-treated. [b] After-treated with copper sulphate. [c] After-treated with potassium dichromate.

From Table 1 it appears that cotton goods may be satisfactorily dyed with extracts obtained from ipil, narra, and tañgile sawdust by the above-described methods.

THE ILOKO SUBSTANTIVAL VOICE

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The difficulty alluded to in connection with the possessives occurs here also in the composition of sentences in which the object is a personal pronoun of the second series, and in which the verb has a possessive (the subject) joined to it. The similarity or rather the absolute equality of both constructions is a practical illustration of what has been said about the construction of sentences in the substantival voice.[1] Examples:

surótenka	I follow you.
surótem	follow him.
surótennatayo	he follows us.
sinúrotdakayo	we followed you.
sinúrotyo idá	you followed them.
surótendaka	they follow you.
díak suróten	I do not follow him.
dínak suróten	do not follow me.
saánnakam a suróten	he does not follow us.
dínakay suróten	he does not follow you.
saánmi idá a sinúrot	we did not follow them.
saánta a sinúrot idá	we did not follow them.
dídak suróten	do not follow me.
saándaka a sinúrot	they did not follow you.
saánda idá a sinúrot	they did not follow them.

1. THE SUFFIX *EN*

A. THE SIMPLE SUFFIX

I. Form of the present: the suffix *en;* Form of the past: the infix *in.*

II. A. This is the most used of all prefixes, infixes, and suffixes of verbs in the substantival construction, and verbal stems that do not allow it are rather scarce. It is really the

[1] We refer the reader to the tables given under Possessives, Anthropos 28 (1933) 692–694, as the combinations and the metamorphoses of the possessives are exactly the same in both constructions.

one almost universal suffix for transitive verbs in the Iloko substantival voice. Examples:

saganáem ti kanék	prepare my food.
tuládendak	imitate me.
gináta\~n̄gko ti áso	I bought the dog.
isú ti inálami	that is what we took.
bináutmo dagití ubbín̄g	did you whip the children?
siká ti inarákupna	it was you he embraced.
sapúlem ti napúkawmo	look for what you lost.
patiényo ti saók	believe my words.
tinun̄gpálda ti bílinko	they obeyed my order.
dawátenda ti líbro	they ask for the book.
lutoénmi ti tinápay	we bake the bread.
pinígisna ti papél	he tore up the paper.
pidútem ti natinnág	pick up what fell down.
daytóy ti basáek	this is what I read.
aniá ti uráyenda	for what do they wait?
siká ti kitáen dagití san̄gaíli	it is you at whom the foreigners look.
tulúyenyo ti saríta	continue the story.
díak inarámid ti inbagám	I did not do what you said.
an̄gáyendakami	they invite us.
tinákawda ti kaldín̄g	they stole the goat.

B. This suffix is used especially:

1. To form verbs meaning: to consider, use, and the like, something for what the stem implies. Examples:

imbagényo ti dákes	you consider the bad as good.
pintásenda ti naalás	they consider the ugly as beautiful.
takrótenmi ti ásoyo	we consider your dog as timid.
bassitém daytóy	do you consider this as little?
linaín̄gko ni gayyémko	I considered my friend as clever.
sin̄gpeténda dagití ubbín̄g	they consider the children as virtuous.
siák ti tináyagda	me they considered as tall.
asín ti apoém	who is your master? (literally: whom have you as master?)
ininaonámi ni Ana	Ann was our elder sister.
inaudiéndak	I am their younger brother.
dínak adipnén	do not use me as a servant.
dayáen ti baláy ni áma	it is at the east of my father's house (literally: my father's house has it at its east side).
amianánen ti lamisáanko	it is at the north of my table.

NOTE 1. A strange construction occurs here: a kind of comparative formed with the verb in *en*, the stem of which is an adjective; the object

is compared with another term with which it is connected by the conjunction *n͠gem*. Examples:

adayoénmi ti baláymi n͠gem ti tálonyo	we consider our house as farther than your rice field.
lináwada ti agámman͠gda n͠gem ti baláymi	they thought their granary larger than our house.
sayaátenda ti kabáyom n͠gem ti kabáyok	they consider your horse as better than mine.

2. To form verbs meaning: to make, to obtain, and the like, something implied by the stem, from a certain material, for instance. Examples:

badoém toy lúpot	make a coat out of this cloth.
sinapínda	they made trousers out of it.
pandilin͠géndα ti inabélda	they make a *saya* out of what they wove.
kawárenyo toy landók	work this iron into a chain.
bunen͠génda kanó	they say they will work it into a cutlass.
manó ti pagáyem ití tálonmo	how much rice do you get from your rice field?
bagasénminto daytá písos	we shall give rice for that peso.
pinin͠ggólna ti boókna	she did up her hair in a chignon.

3. With the cardinal numbers of tens, hundreds, and so on, and the names of coins, and the like, to form verbs meaning: to complete a number, a sum, for example, that lacks some units, or the like. Examples:

san͠gapuloém dagití waló a sípin͠g	increase the eight centavos to ten.
duá puloém ti san͠gapúlo ket talló n͠ga inálam	increase to twenty the thirteen you took.
pisósenmi	we make it a peso.
salapiénda pay ti duá a peséta	let them increase first the forty centavos to fifty.

4. With the names of the parts of the body, to form verbs meaning: to use a member of the body for a certain work; in this case, the first open syllable of the stem together with the next consonant if there is any, has to be reduplicated. Examples:

ramramáyenda ti agpídut	they pick it up with their fingers.
im-imáenmi ti agkáli	we dig with our hands.
matmataéntayo ti agsúkat	let us measure it by sight.
saksakácnyo daytá	do it with your feet.

B. COMBINATIONS

I. All these combinations form their past in the same way as the simple suffix *en*, by changing the suffix *en* into the infix *in*.

II. The following are the most noteworthy combinations:

1. With the prefix *tagi*, indicating property or possession; consequently the combination generally means: to consider something as having a certain quality. Examples:

tagipatgénda ti saók	they prize my words.
tagibassiténda	they consider it as small.
tagialasénmi ti agkastá	we consider acting that way as unbecoming.
tagidaksénmi daytá	we consider that as bad.
tagikawesénna ti gárit	she likes striped cloth for a dress.
tagikawesénmi dagitá táo	we esteem those men very much (as much as our clothes).
tinagisayáatko daytá baláy	I considered that house as nice.
tagidagsenénmi ti agyán ditóy	we think it hard to stay here.
tagibantótenyo daytóy a káyo	you consider this wood as heavy.
tinaginâyonmo	you used it a long time.
tagilakoénda ti bunéñg	they sell cutlasses.

2. With the prefix *kara*, indicating repeated action. Examples:

karakuddoténnak	he nips me continually.
karapidútenna ti bató	he picks up stones continually.
karakugtárenda ti ásomi	they kick our dog continually.
karapugsátenyo ti gálut	you snap the band continually.

3. With the prefix *sag* of distributives. Examples:

sinagduduána idá ñga inbáon	he sent them two by two.
sinagpipitó	seven by seven.
sinagsañgkarañgkáy	piece by piece (of meat).
sagpamitlóem idâ	(give) them each three times.
sagpaminpaténdatayo a pakanén	they feed us each four times.
saglilimaénda idá a baûten	they whip them five by five.

NOTE 2. Some other combinations and forms. Examples:

sañgkanaígem daytá lúpot	cut this cloth into pieces (of a certain width).
kaiddaénnak	lie down with me.
pakinakménna daytá	he thinks that.
sañgailiénda ti kaaróbami	they have our neighbors as guests.
lippiûtem	clap it.

2. THE SUFFIX *AN*

I. Form of the present: the suffix *an;* Form of the past: the infix *in* and the suffix *an*.

II. A. This is also a much used suffix of the substantival voice, and it generally indicates that something is put, made, or placed, in something, or taken off, or out, from something; this suffix really implies the notion of the locative or ablative. For example, *sagádenna ti tápok* means: he sweeps the dust (a simple action); *sagádanna ti silíd* means; he sweeps the room (an action in the room); *sursuroém:* learn it; *sursuroám:* teach him; *takáwek:* I steal it; *takáwak:* I rob him; *siníkapko:* I considered him as astute; *sinikápak:* I fooled him.

We have seen some practical uses of this suffix in connection with substantives [2] and in connection with substantives with verbal notions,[3] where the truth of the above statement has been amply proved. But to further illustrate it we shall give below some of the most common uses of this verbal suffix *an.* However, the universally correct discrimination between the suffixes *en* and *an* has to be learned by use. Examples:

puóranna ti káyo	he burns the wood.
abáñganda ti baláy	they rent a house.
sukatám ti bádom	change your coat.
inayabánmi idá	we called them.
ramanántayo	let us taste it.
anúsam ti kadawiánna	bear with his customs.
isú ti kalikagúmanyo	that is what you desire.
díka tarigagáyan ti asáwa ti pádam a táo	do not covet your neighbor's wife.
díka agúman ti saánmo a kúkua	do not covet your neighbor's goods.
nirañggásanda	they injured it.
bay-ám daytá	leave that.
tawáram daytá manók	bargain for that chicken.
bantáyanyo dagití annákyo	watch your children.
indeñgányo ti balákadna	heed his advice.
sambútam ti nadadáelmo	make good for what you spoiled.
bayádanna ti útañgna	he pays his debts.
balíwam ta dákes	do it again as it is bad.

B. The suffix *an* forms verbs meaning:

1. To place what the stem implies into, on, over, and so forth, something. Examples:

kalubám ti báñga	cover the pot.
asinánda ti kárne	they salt the meat.
dinanumánmi ti árak	we added water to the wine.
lanáanda dagití sapátos	they oil the shoes.
dapoányo ti rugít	strew ashes over the dirt.
sinupótanna ti púñgan	he covered the pillow with a pillow-case.

[2] Anthropos 26 (1931) 472, 474.

[3] Iloko adjectival voice. Philip. Journ. Sci. 69 (1939) 223.

atapántayo ti lamisáan	let us wedge the table.
ti anákna ti kinawesák	his child was the one I clothed.
gatásam ti kapí	add milk to the coffee.
lansáam dagití ladáwan	nail the pictures.
tinakupánda ti bádoda	they patched their coat.
tapiám ti bíto	put a stone over the pit.
díkam apúgan ti gawéd no agmamákami	we do not sprinkle lime over the betel when we chew.
pagáyanda ti tálonda	they sow rice in their rice field.
tayúmanminto	we shall sow indigo in it.
kapásanyo daytá bañḡkágyo	sow cotton in that field of yours.
balatóñḡanda	they sow green gram in it.
siloám ti billít	ensnare the bird.
appanám	bait it.
rikpám ti roáñḡan	close the door.

2. To do something in, on, or at a certain place, for, in behalf of, and so on, somebody. Examples:

raepám ti tálonmo	transplant rice in your rice field.
kuskúsam ti lamisáan	scrape the table.
saplídam dagiti alikámen	dust the furniture.
asín ti apálan dagitá	whom do these envy?
awán ti tinakáwak	I robbed nobody.
kararáganmi ti katalékmi	we pray to our advocate.
dawátakto ti gayyémko	I shall ask my friend.
lukatám ni ína	open for my mother.
sinaksiánmi ti lakáy	we testified for the old man.
kiddayám dagitóy	wink at these.
layátanda ti áso	they threaten the dog.
pinayapáyandak	they beckoned me.
patítam no dumatéñḡ	ring the bells for him when he arrives.
sibugám dagití múla	water the plants.
uprám dagitá	wet those.
warísanmi idá	we besprinkle them.
tulóñḡam ti kaaróbam	help your neighbor.
pinuloták ti agbugsót	I anointed the dying.
kinariánna ti gayyémna	he made his friend promise.

3. To augment, to diminish or the like, something. Examples:

pinutólanda ti tulisán	they beheaded the robber.
silpoányo ti adígi	joint another piece to the post.
nayónanyo pay	you still augment it.
degdegánna ti gúrana	it inflames his hate.
kartíbam ti lúpot	cut off a part of the cloth.
kissayám ti danúmna	diminish its water.
linukásanda	they uncovered it.
lukatám ti táwa	open the window.
pukísam	cut his hair.
kayásanda ti kawáyan	they strip bamboo.

4. To earn something by what the stem implies. Examples:

tinalónak ti duá a burnáy	I earned two jars by working the rice fields.
salapí ti dinaítanna	she earned fifty centavos by sewing.
manó ti tinibbiányo	how much did you earn by spinning?
diniñgoánmi ti maysá a baláy	we earned a house by raising animals.

5. To pay or offer a number of pesos and so on, for something. Examples:

manoánda ti bagásko	how much do they offer for my rice?
pinitoánmi a salapí	we paid fifty centavos.
minanoányo ti kabáyona	how much did you pay for his horse?
tinalloánna a písos	he paid three pesos.
limaántayo	let us offer five for it.
pisósanda	they offer a peso for it.

NOTE 3. The suffix *an* is sometimes combined with the infix *an*. Example:

banetbetánna daytá	he strikes that one with force.

3. THE PREFIX *I*

A. THE SIMPLE PREFIX

I. Form of the present: the prefix *i;* form of the past: the prefix *in.*[4]

II. A. This prefix is used extensively in substantival constructions, and because it nearly always remains, whatever prefix or suffix is joined to its stem, and has besides an extreme versatility of meaning, this prefix has a kind of ubiquitous character and is perhaps the most common of all prefixes, infixes, and suffixes used in Iloko.

The prefix *i* generally indicates that something is used to perform the action implied by the stem; it is a real instrumental prefix. For example: *gatáñgenna ti áso* means: he buys the dog; *igátañgna ti salapí* means: he pays half a peso (literally: he buys with half a peso); *rikpám:* close it (the opening); *iriképmo:* close with it (with the frame of boards); *lukatám:* open it (the opening); *ilukátmo:* open with it (with the frame); *surátenna ti pabláak* means: he writes a notice; *surátanna ti papél* means: he writes on paper; *isúratna ti konák* means: he writes what I say.

However, the universally correct discrimination between the suffixes *en* and *an* and the prefix *i* has to be learned by use; for

[4] Anthropos, Notes on Iloko 23 (1928) 1038, 1039.

example: *kabilen* means: to beat; *ikábil* means: to place. Examples:

daytóy ti insañgpétda	this is what they brought home.
aniá ti inpatáy ni amám	of what did your father die?
ikarík kenká	I promise you.
yúpermo ti kápas	dip the cotton in water.
inyálisda ti báñga	they moved the pot.
idurón ni gayyémko	my friend pushes him.
idáwatnak ken apóm	intercede for me with your master.
ápay ñga inlemméñgyo	why did you hide it?
yúlogmo ití saó ti ilóko	translate it into Iloko.
idissóda ti amiténda	they put down what they carry.
ikastóymo	do it so.
inyárigna kenkuána	he compared it with him.
ikálida ti púsa a natáy	they bury the dead cat.
ipúlañgyo ti binúlodyo	return what you borrowed.
isublím ta inálam	bring back what you took.
iturédmo	stand it.
yaplágda ti ikamén	they spread the mat.
iserréktayo ti págay	let us put the rice inside.

B. The prefix *i* is used especially with names of places, to form verbs meaning: to bring, to carry and so on, something into, on, or the like, the place indicated by the stem. Examples:

iruármo dagitóy	put these outside.
yunégda dagitá	they put those inside.
iditóymo	put it here.
idiáyna	he puts it there.
yasidégmi	we put it near.
inyadayóyo	you put it far away.
iñgátom ta magaw-átko	lift it up so that I can reach it.
ibabáda pay	they still lower it.
inyabútmi	we put it in the hole.

B. COMBINATIONS

I. Adjectival: The prefix *i* may be joined to almost any adjectival prefix, in which case the whole combination remains adjectival, and the different forms of the simple adjectival prefix are used in these combinations. The prefix *i* adds to the adjectival prefixes its own instrumental meaning.

1. The prefix *agi* (past: *nagi*). Examples:

agisápulka no awán	look for some if there is none.
siák ti agisúrat	I shall write it down.
nagibáleskami	we took revenge.
inkayo agibilág ití págay	go and sun the rice.
agibléñg	he relieves his bowels.
díkayo agilunód	do not curse.

nagiruárda iti págay	they drew out rice.
agipagná iti nuáñg	he brings a carabao around.
pagiwarnák	newspaper.
sadín ti pagibleñgán ti ubíñg	where does the boy relieve his bowels?
agilásinka iti kayátmo	put on one side whatever you like.
managilíarí ñgem awán ti itédna	he always promises but he gives nothing.
aniá ti pagisañgpetánna kadagitá ditóy	why does he bring those here?
napalálo ti panagikárona kadagiti basbásolna	he expiates his sins to excess.
intonanó ti panagibatómi	when do we throw stones?

2. The prefix *agkai* (past: *nagkai*). Examples:

agkaipígis ti bádok	my coat always gets torn.
agkaiwará ti lúpot	the clothes lie around.
agkaisaroñggáñgat dagití aspíli	the pins lie around.
nagkaisarombíñgit dagití warnákan	the papers lie around.
agkaidissó ti báñga	pots stand all over the ground.
agkaitibkúl ti lakáy	old men often stumble.
nagkairegrég ti bagásna	his rice spilt all around.
agkaiwáris dagití bukél	the seeds are scattered everywhere.
agkaisublí ti súratko	my letters come back repeatedly.
aniá ti pagkaidissoán ti báñga ditóy	why do pots stand all around here?
ti kuártok ti nagkaisaroñggañgátan dagití dágum	the needles lay all over my room.
masansán ti panagkairegrég ti bagásna	his rice is often spilt.

NOTE 4. We have seen under the adjectival prefix *ma* how the prefix *agka* gives the original term in *ma* something of an active meaning; the same happens with the prefix *agkai:* it gives the original term in *mai* something of an active meaning, and besides includes the notion of plurality, while the prefix *agkarai* includes that of repetition, and in this resembles the meaning of the reduplication of the first two syllables of the stem. Examples:

maisublí ti pirák: (the) money is brought back.
agkaisublí ti pirák: money comes back, several times, different money.
agkaraisublí ti pirák: the money comes back, continually, the same money.
agsublisublí ti ragádi: the saw goes back and forth.

3. The prefix *agkarai* (past: *nagkarai*). Examples:

agkaraibóoñg daytá ubíñg	that child always breaks things.
nagkaraitedtéd ti liñg-étna	his perspiration trickled down abundantly.
agkaraipugsát ti talí	the rope snaps continually.
agkaraitubláh	he falls continually on his face.
agkaraibalittádda	they turn over repeatedly.

agkaraibelléñg̃ ití bagás	he always throws away rice.
agkaraisublída	they always return.
agkaraipatáy ti sílaw	the light goes out continually.
aniá ti pagkaraikugtáran ti kabáyo	why does the horse kick all the time?
sadín ti nagkaraipidútanna kadagití bató	where did he continually pick up stones?
asín ti pagkaraitupráan ni lakáyko	on whom does my husband continually spit?
kasanó ti panagkaraidánug ti apómi	how does our grandfather cuff all the time?

NOTE 5. The difference between *agkara* and *agkarai*, whenever they are used with the same stem, consists chiefly herein: *agkara* generally means that the subject suffers repeatedly the action indicated by the stem, *agkarai* generally means that the subject does repeatedly the action indicated by the stem. For example:

agkarakuddót: he is nipped continually.
agkaraikuddót: he nips continually.

4. The prefix *makai* (past: *nakai*). Examples:

díak makaitaráy kenkuána ta nadagsén	I cannot run away with it because it is heavy.
nakaipúpokda ití adú únay ñg̃a ikán	they caught many fish.
isú ti makaigáwid kenkuána	he it is who keeps him back.
díak makaipán ití súrat	I cannot carry the letter.

5. The prefix *makapagi* (past *nakapagi*), used very rarely. Examples:

makapagiserrékka	can you put them inside?

6. The prefix *makipagi* (past: *nakipagi*), used very rarely. Example:

siák ti nakipagiruár	I helped bring them out.

7. The prefixes *mañg̃i* and *mai* will be studied later.[5]

II. Substantival: The prefix *i* is used especially in the following combinations:

1. The prefix *i* and the suffix *an* (past: *in . . . an*); in this case there may be a double object in the nominative. This combination is used:

a. To indicate that something (first nominative on account of *i*) is done, made, and so on, for, in behalf of, somebody (second nominative on account of *an*). Examples:

yaramídannak ti baláy	make me a house.
ingatáñg̃andakayo ti báwañg̃	we bought garlic for you.
isapúlankanto ti nuáñg̃	I shall look for a carabao for you.

[5] The transitive prefix *mañg̃* and the prefix *ma*.

idaítannaka ti bádo	she will make you a coat.
inbayoánna ti kabsátna	she pounded rice for her sister.
ilutoándakayo ti inapúy	we shall cook rice for you.
idawátannak ti árak	ask wine for me.
isagádanna ti iñgána	she sweeps it for her friend.
itabásandakami ti bádo	they pattern out a coat for us.
isubalítam ti okóm	answer for the judge.
inlakoánna ti gayyémko ti duá ñga áso	he sold two dogs for my friend.
isaoám ti bagím	speak for yourself.
ikitáannak ti limá	look up five for me.

b. To indicate that the action or object implied in the stem is the means one uses to pay a debt, to earn something, and the like.[6] Examples:

idaítak ti útañgko	I pay my debt sewing.
inyablánna ti útañgna	she paid her debt weaving.
indiñgoák ti limá salapí	I earned two pesos fifty by raising animals.
intalónak ti písos	I earned a peso by working rice fields.
yablák ken Pédro	I earn it by weaving for Peter.
inubiñgák idá a duá	I served both as a boy.

2. The prefix *ika* (past: *inka*). In this complex prefix the prefix *i* gives the verb its notion of instrumentality, and the stem with the prefix *ka* gives it its instrument. Examples:

inkasígudna ti kinasiñgpét	he has always been virtuous.
inkaubíñgko toy lidáyko	this sorrow of mine dates from my childhood.
ikaláwana ti abút	he widens the hole.
inkalubbónmo ti ubíñg	you joined the child to (the other one).

3. The prefix *ika* and the suffix *an* (past: *inka . . . an*). In this combination the prefix *i* gives the verb its notion of instrumentality, and the stem with the combination *ka . . . an* gives it its instrument. Examples:

inkaubiñgánna ti nakigubát	he fought from childhood on.
inkarigátanda ti bagída	they chastised their bodies.
ikarigátanda a biróken	they do their utmost to find it.

4. The prefix *karai* (past and present). This prefix indicates repeated action; the difference between the combination *kara . . . en* and the complex prefix *karai* is the same as that between the suffix *en* and the prefix *i*. Examples:

[6] Page 15.

karaikuddótnak	he nips me continually.
karaisublída ti págay	they always return the rice.

NOTE 6. A. The following combinations are used very rarely:

a. The prefix *itagi* (past: *intagi*). In this combination the prefix *tagi* adds the notion of property or possession to the simple prefix *i*. Example:

intagiláyonna ti biágko	he preserved my life.

b. The prefix *ipaka* (past: *inpaka*). The prefix *paka* is the instrumental prefix derived from the prefix *maka*. Examples:

ipakaonák kadakayó	I foretell you.
inpakaammóna ití gayyémna	he imparted it to his friend.
inpakamaysána ti agádal	he only thought of learning.

c. The prefix *ipaki* (past: *inpaki*). The prefix *paki* is the instrumental prefix derived from the prefix *maki*. Example:

ipakidáwatmo daytá kenkuána	ask that from him.

d. The prefix *i* is used, although rarely, with some combinations indicating rivalry, reciprocity, and the like. Example:

kayátna ñga igasangásat ti biágna	he likes to risk his life.

B. The prefixes *isañga* (past: *insañga*), *isañgai* (past: *insañgai*) and *sañgkai* (past and present), having the notion of unity or concomitance combined with that of instrumentality, are of very rare occurrence and sometimes considered incorrect. Examples:

insañgapúorna kadakuáda ti káyo	he burned wood with them.
isañgabílañgna	he includes it in his account.
isañgaáwisko ti kabsátko	I also coax my brother.
isañgabáñgonna	he raises it also.
insañgaibáonna idá	he sent them also.
sañgkaitúgotda ti bálonda	they also take provisions with them.

4. THE PREFIX *IPA*

A. THE SIMPLE PREFIX

I. Form of the present: the prefix *ipa;* form of the past: the prefix *inpa.*

II. This prefix indicates:

1. Application, attribution, and the like. Examples:

ipakánmo ti págay ití kabáyo	feed rice to the horse.
ipaáymo ñga ayát ta yégmo	please, bring it.
awán ti inpaáyna kaniák	he gave me nothing.
ipatákawda ti áso ken Juán	they accuse John of stealing the dog.
ipaanákda kenkuána daytá ubíñg	they consider that child as his.
inpabásolmi kenkuána ti pannakapúkawna	we blamed him for its loss.
ipapánna a kastá	he supposes it to be so.
inpabóoñgmi kenkuána ti piñggán	we blamed him for breaking the plates.

ipainúmmo ti árak	give (him) wine to drink.
awán ti ipasósona ití anákna	she cannot give her child the breast.
ipapúdotmi ti dinen̄gdén̄g	we heated the cooked vegetables.
inpaárabda dagití nuán̄g	they brought the carabaos to the pasture.
ipapílitna ti kayátna	he insists on what he likes.
ipagapóyo kaniák	do it in consideration of me.

2. The use made of something. Examples:

awán ti bató n̄ga ipapún̄ganna	he has no stone to use as a pillow.
inpasúpotda ti kallogón̄gda	they used their hats for purses.
ipakuártata dagitóy a bató	let us use these pebbles as if they were money.
inpasagaysáymi dagití rámaymi	we used our fingers for combs.
ipaárakna ti danúm	he uses water as if it were wine.
ipakátreyo ti datár	use the floor for a bed.
ipapalán̄gkatayo ti bató	let us use the stone for a chair.
inpapin̄ggánda ti bulón̄g ti sabá	they used banana leaves for plates.

3. The direction in which something is put, brought, and so on. Examples:

iparabáwmo ití lamisáan	put it on the table.
ipaamiánanmi dagitá	we carry those northward.
inpasúlida idá	they put them in the corner.
ipababána ti labbá	he lowers the basket.
ipan̄gátoyo ti burnáy	hand up the jar.
ipadáyada ti nuán̄g	they bring the carabao eastward.
inpaten̄gn̄gámi ti ubín̄g	we placed the child in the middle.
dakamí ti ipaabagátanda	it is us they carry southward.
ipaláudtayo daytá	let us carry that one westward.
inpaígidda ti karretón	they brought the cart near the edge.

NOTE 7. When the object has to be put in a certain direction with reference to another object, the combination *pakin . . . en* (past: the prefix *pinakin*) is used. We have seen that the prefix *akin* is followed by a glottal stop when the stem begins with a vowel; this prefix *pakin*, which is derived from *akin*, follows the same rule.

The combination *pakin . . . en* should really find its place under the verbs implying order or permission, but for the sake of convenience we place it here. After all, the prefix *ipa* itself is only a combination of *i* and *pa*, and should find its place under the same heading as *pakin . . . en*. Examples:

pinakinbabáda ti líbro	they put the book beneath.
pakin-unegém	put it on the inside.
pakinrabawém ti tinápay	put the bread above.
pakindayáenmi ti báka	we put the cow at the east side.
pinakinn̄gátoda ti pan-áw	they put the cogon the uppermost.
pakinn̄gatoénnak	he lifts me above the rest.

B. COMBINATIONS

I. Adjectival: The complex prefix *agipa* with the different forms of the simple prefix *ag*, occurs sometimes but rarely. Examples:

nalaiñg ñga agipapán	he is very suspicious.
agipatayábda ti tápok	they throw up dust.
nagiparuár kadagití báñga	he brought the pots outside.
awán ti pagiparuárko	I have no means to bring them outside.
ti dálan ti nagipatayabánna ití tápok	he threw up dust in the road.
kaanó ti panagipaárabmo kadakuáda	when did you bring them to the pasture?

II. Substantival: The prefix *ipa* may be combined with other prefixes or suffixes, and the past form of *ipa* (*inpa*) is retained in these combinations, which are all very seldom met with.

1. The prefix *ipatagi*. Examples:

ipatagiláyonmo kaniák	preserve it for me.

2. The prefix *ipasi*. Example:

ipasinánamda	they offer it to be tasted.

3. The combination *ipa . . . an*, with a double nominative. Examples:

ipakitáanna komá idá	he should show it to them.
inpatagikuáam	you gave it to him as his property.
ipaayánnak ti kayátko	give me what I like.

5. THE PREFIX *MA*

I. Form of the present: the prefix *ma;* form of the past: the prefix *na*.

II. All the prefixes and suffixes of the Iloko subtantival voice which may be combined with the adjectival prefix *ma* may also be combined with the substantival prefix *ma;* therefore we shall give examples of the use of this particular prefix later on.

III. This prefix indicates active possibility and, when used with the form of the past, indicates completion of the action. Examples:

maarámidko ti konáyo	I can do what you say.
madáitko ti bádom	I can sew your coat.
matarimáanna no kayátyo	he can arrange it if you like.
malpásmi no bigát	we shall finish it for tomorrow.
nadánonko ti Kabúgaw	I reached Kabugaw.
nainúmko ámin ti árakda	I drank all their wine.

matúluymi ití nalaká	we can continue it easily.
manó ti maláonna	how much does it hold?
nalpásmi	we finished it.
nadáitko	I sewed it.

NOTE 8. A. The complex prefix *masi* or *masin*, explained under the adjectival prefix *ma*, may also occur with the substantival construction. Example:

masipuónko daytóy a talí	I can buy this entire rope.

B. The difference between the adjectival prefixes *maka*, *ma*, and the substantival prefix *ma* may best be illustrated in the following way:

a. *makaarámidak ití baláy:* I can make a house (indeterminate).
maarámidko ti baláy: I can make the house (determinate).
maarámid ti baláy: the (or, a) house is made (passive).

b. *nakaarámidak ití baláy:* I made (finished making) a house (indeterminate).
naarámidko ti baláy: I made (finished making) the house (determinate).
naarámid ti baláy: the (or, a) house was made (passive).

The adjectival prefix *maka* and the substantival prefix *ma* have both an active meaning (active possibility or completion of the action), the first being adjectival (indeterminate object), the second substantival (determinate object). The adjectival prefix *ma* represents the passive voice.

C. The difference between an ordinary substantival prefix or suffix and one combined with *ma*, may best be illustrated in the following way:

daítek ti bádo: I sew the coat.
madáitko ti bádo: I can sew the coat.
dináitko ti bádo: I sewed the coat (finished or not).
nadáitko ti bádo: I sewed the coat and finished it.

One may hear expressions like this:
dináitko n̄gem díak pay nadáit: I sewed at it but did not yet finish it.

6. THE COMBINATION *PI . . . EN*

I. Form of the present: the prefix *pi* or *pin* and the suffix *en;* form of the past: the prefix *pini* or *pinin.*

NOTE 9. A glottal catch follows the prefix in *in* whenever the stem begins with a vowel.

II. This combination is used with numbers to indicate how often something is done.[7] Examples:

piduáem ti agtaráy	run twice, run again.
díakto piduáen ti agbásolen	I shall not sin again.
pinitlóna ti nagdáwaten	he asked three times already.
pin-innemém	do it six times.

[7] For the changes in prefix and number, see The Substantive. Anthropos **26** (1931) **473**.

III. The following combinations occur sometimes, although rarely:

1. Adjectival:

a. The complex prefix *agpi* or *agpin,* with the different forms of the simple prefix *ag.* Examples:

agpitlóka ñga agbáyo	pound rice three times.
agpinsántayo	let us work together.
sadín ti nagpinpatányo	where did you do it four times?
intonanó ti panagpinwaló ni Ana	when will Ann do it eight times?

b. The complex prefix *pumi* or *pumin* (past: *pimmi* or *pimmin*). Examples:

pumiduáka a pumídut	pick things up twice.
pimmin-innémkami	we did it six times.

2. Substantival:

a. The prefix *ipi* or *ipin* (past: *inpi* or *inpin*). Examples:

ipinpátmo a baliksén	pronounce it four times.
inpinlimáda ñga inbagá	they said it five times.

b. The prefix *ikapi* or *ikapin* (past: *inkapi* or *inkapin*). Examples:

ikapinpátna a mapán idiáy	he goes there a fourth time.
inkapinsiámna	he did it a ninth time.
inkapinpitóda	they did it a seventh time.

7. THE COMBINATION *KA . . . EN*

I. Form of the present: the prefix *ka* and the suffix *en;* form of the past: the prefix *kina.*

II. This combination is used mostly with stems that imply the notion of quantity, time and so on, and forms verbs meaning: to augment, to retard, and so on. Examples:

kaaduénna ti kanén	he augments the food.
kaatiddagényo daytá siñgdán	lengthen that cord.
kabayagénda ti agpátit	they keep on ringing (the bells).
kaladáwenda ti mañgán	they put off eating.
kaababaéntayo ti talí	let us shorten the rope.
kinasápami ti immáy	we came earlier than usual.
kinabassítda ti árak	they diminished the wine.
kinabiítmo ti nagluálo	you shortened your praying.
kañgináenna ti ayátna	he augments his charity (literally: he increases the value of his love).
kalutoém daytá	cook it well, thoroughly.

8. THE COMBINATION *KA . . . AN*

I. Form of the present: the prefix *ka* and the suffix *an:* form of the past: the prefix *kina* and the suffix *an.*

II. This combination is used with cardinal numbers to indicate to what number a lower one has to be increased.[8] Examples:

katloám	make it three.
kalimaánnakayo	he increases your number to five.
kinasiámanda dagití nañgamít	they caused those who carried them to be nine.
kaduapuloánmi idá	we increase their number to twenty.
kinawaloányo dagití ubbíñg	you increased the number of the children to eight.

NOTE 10. Sometimes the simple suffix *an* is used instead of *ka . . . an*. Example:

talloánnakami	he increases our number to three.

9. VERBS IMPLYING ORDER OR PERMISSION

When we say order or permission, there is understood a whole amount of other subordinate meanings, which will be explained more extensively under the combination *pa . . . en*.

I. The notion of order or permission may bear either on the action, or on the subject, or on the object.

A. For instance, if the Iloko wants to order the action implied in the verbal stem *ságad* (sweeping), the order bearing on the action, he will say:

agpaságadak (an adjectival construction derived from an adjectival prefix), I order sweeping;

agpaságadak ití ubíñg, I order a boy (indeterminate or without stress) to sweep (anything, indeterminate);

agpaságadak ití silíd, I order (somebody, indeterminate) to sweep the room (indeterminate or without stress).

B. If he wants to order somebody to sweep something, the order bearing on the subject of the adjectival verb, the subject of *agságad,* he says:

pagsagádek ti ubíñg (a substantival construction derived from an adjectival prefix), I order the boy (determinate or with stress) to sweep (anything, indeterminate);

pagsagádek ti ubíñg ití silíd, I order the boy (determinate or with stress) to sweep the room (indeterminate or without stress).

C. If he wants to order something to be swept, the order bearing on the object of the substantival verb, the object of *sagádan,* he says:

[8] For the changes in the number, see Cardinal Numbers, IV, Note 1. Anthropos 28 (1933) 711.

pasagádak ti silíd (a substantival construction derived from a substantival suffix), I order the room (determinate or with stress) to be swept (by anybody, indeterminate);

pasagádak ti silíd ití ubiñg, I order the room (determinate or with stress) to be swept by a boy (indeterminate or without stress).

II. Now as to the form of the verb:

A. When the order bears on the action, the prefix *pa* follows directly the original prefixes of the adjectival verbs, in the forms either of the present or of the past. These combinations are adjectival.

All the forms of the simple adjectival prefixes which have been studied in the preceding paper [9] are of use here.

Here follow the most important combinations:

1. The prefix *agpa* (past: *nagpa*). Examples:

agpaálaak ití asín	I send for salt.
isúda ti nagpasápul	they had it looked for.
awán ti agpaláko	nobody has it sold.
nagpapúkiskami	we had our hair cut.
nagpaatépkayo	did you have it roofed?
díkam agpadeñgñgég kenkuána	we do not think he can hear.
agparígat ti lakáy	the old man is in a difficult position.
agpasokmón ti gayyémko	my friend treats (us) to a drink.
agpapaanák daytá bakét	that old woman is a usurer.
managpabáutda	they always order whipping.
managpataráy dagití ubbíñg	the boys always have them run.
addá pagpainúmmo	have you something with which to give (them) to drink?
aniá ti nagpasagádam	why did you tell (them) to sweep (it)?
pagpalpaliwaán	consolation.
ti pagpadpadagusán ti ílimi	the hotel of our town.
awán ti pagpatagabuánmi	we have no place where we can offer our services as servants.
sadín ti nagpagatáñgam	where did you have it bought?
kaanó ti panagpalútomi	when will we have it cooked?
idí kalmán ti panagpaayábda	they had (us) called yesterday.
kasanó ti panagpabírokmi	how can we have it looked for?

NOTE 11. a. The prefix *agpa* is also used to indicate direction toward the place indicated by the stem. It corresponds to the substantival prefix *ipa*. Examples:

nagpaláud itáy	he went westward just now.
agpabontókkami	we go toward Bontok.
agpaditóy dagití agsakáy	the riders come in this direction.

[9] Philip. Journ. Sci. 69 (1939) 223.

nagpaabagátanda itáy malém	they went southward this afternoon.
agpaidiáyka	go in that direction.
nagpadayáanna ta nagbutéñg	he went eastward because he was afraid.
kaanó ti panagpaamiánanna	when did he go northward?
intóno bigát ti panagpalawágmi	tomorrow we shall go toward Lawag.

b. The prefix *agpa* may be used with syncopated stems in which the last vowel is reduplicated.[10] Examples:

nagpalsíit dagití ubbíñg	the boys catapulted.
agpaltóog or *agpaltóg*	he shoots a gun.
aniá ti pagpalsoótam	why do you shoot your air gun?
intonanó ti panagpalsíityo	when will you catapult?

c. Other complex prefixes derived from the above: *agpai, agpa . . . inn* (rarely used), *agpinna, agpagin* (rarely used). Examples:

agpaikábil ti lakáy	the old man has it placed.
aniá ti nagpaisurátanna	why does he order it written?
kaanó ti panagpaipánda	when did they have it carried?
nagpatitinnúloñgda	they told (them) to help one another.
agpipinnaipánda	they ask one another to carry it there.
nagpipinnadáyaw dagití kaaróbami	our neighbors praised one another.
aniá ti pagpipinnaayán dagitóy	why do these ask one another to apply it?
kasanó ti panagpipinnagásattayo	how can we strive for the best luck?
agpagintutúleñg	he has (them) simulate deafness.

d. The prefix *agpañg* differs from *agpa* in the same way as the transitive prefix *mañg* differs from the intransitive prefix *ag*. Examples:

agpañgasáwa ni Juán	John marries off his son.
agpammukél dagitóy ñga ubbíñgen	these girls are getting breasts already (literally: have their breasts becoming round).
isú ti pagpanakkélda	that is what they use to have it grow.
isú ti nagpannurayák	he it was I waited for (for example, to take the lead; literally: whom I made the ruler, *turáy*).

2. The prefix *agpaka* (past: *nagpaka*). This form is used only in a few expressions. Examples:

saán ñga agpakatúrog daytá ubíñg	that child does not allow one to sleep.
agpakarígat toy púsok	this heart of mine is perplexed.
nagpakatáo	did he treat (you) as a man?
dagití agpakadinámag	the renowned ones.

3. The prefix *makapa* (past: *nakapa*). Examples:

[10] See The Adjectival Infix *An*.

makapabíleg ti árak	wine strengthens.
makapabaknáñg ti gagét	thrift makes rich.
isú ti nakapasayáat ití baláymo	that is what made your houses beautiful.
makapasiñgpét ti ánus	patience makes virtuous.
makapasúrotkayo ití maysá ití konáyo	are you able to have even one believe what you say?
róot a makapatúrog	narcotic herbs.
makapakápuy ití bílegna	it diminishes his strength.
nakaparuród	it made one angry.
makapagúra ti dákes a kadawián	bad customs make one hate people.
aniá ti pakapapatiánna	how can he make people believe?
sadíno ti nakapapañgláwanna	where did it make people poor?
kaanó ti pannakapadalápusna	when did he jostle (them)?

NOTE 12. Another complex prefix derived from the above is *makapai* (past: *nakapai*). Example:

díak nakapaipán kadagitóy	I could not have these things carried there.

4. The prefix *makipa* (past: *nakipa*). Rarely used. Examples:

mapán makipaokóm	he also goes to be judged.
nakipataráyka	you also had them run.
ínkayo makipainúm	go also to water them.
nakipaálaak met	I also had (them) brought.
kaanó ti pannakipalútona	when did he also have it cooked?

NOTE 13. Another complex prefix derived from the above is *makipai* (past: *nakipai*). Rarely used. Examples:

napán nakipaisañgpét	he also went to have it brought in.
siák ti nakipaibílin	I was the one who also had it ordered.

5. The complex prefixes derived from the simple prefix *mañg* will be explained later on.

B. When the order bears on the subject, the first consonant of the principal prefixes of the adjectival voice is changed into p, or a p is joined to the prefix if it begins with a vowel, and the suffix *en* is joined to the stem. For the past forms, instead of the suffix *en,* the infix *in* is inserted after the initial p. The only exception is the infix *um,* which is changed into the prefix *pa: pa . . . en* (past: prefix *pina*). These combinations are substantival.

When the simple prefix allows this combination, so do also generally the complex prefixes derived from that simple prefix; so, for example, if the simple prefix *ag,* which allows this combination (*pag . . . en*), is combined with other prefixes into

agi, agpa, and the like, the latter also allows these combinations, of *ag* (*pagi . . . en, pagpa . . . en,* and so on).

Here follow the most important combinations:

1. The prefix *ag* is changed into the combination *pag . . . en* (past: prefix *pinag*). Examples:

pagsurátem ni Luís	make Lewis write.
paggatáñgenda ti gayyémko kadagití áso	they make my friend buy dogs.
dakamí ti pagdaítenda	we it is whom they order to sew.
pinagáwidmi idá	we sent them back.
asíno ti pagtaktákem	whom do you want to tarry?
pagpakadáentayo dagití táo	let us dismiss the men.
pinagsublída dagití kaaróbada	they sent back their neighbors.
ápay a dídakami pagtugawén	why don't you make us sit down?
pagbasáem ti anákmo	send your child to school.
pinaginanámi ti allawági	we told the carpenters to rest.
pagsaganáem ni Artúro ití pagid-daán	tell Arthur to prepare the bed.
pinagsaplítdak	they told me to whip (them).
pinagdátana	he made him lie on his back.
dínak pagmataén	do you think I have no eyes?
pinagarádomi ti ulitégmi	we told our uncle to plow.
pagbayabásenda ti bakét	they tell the old woman to gather guavas.
pinagsakítda ti amáda	they made their father ill.
pagmaestráenda ni Catalína	they make a teacher of Catherine.
pinagragsáknakami ti íkitmi	our aunt made us happy.
paguppatém dagití mañgamít	make the carriers four.
pagsintíkem dagití ubbíñg	tell the children to play at marbles.
pagkapamitloém	make him do it a third time.
pagkaduáem	give him a companion.
pinagkalúgan ni Juán dagití an- nákna	John told his children to ride in the same carriage.
pinagkabbaláydakami	they ordered us to live in the same house.
pagsisinnublátenna idá	he has them take turns.
paglinnaiñgéntay idá	let us have them vie with one another in cleverness.
pagtinnulóñgem dagitá	tell those to help one another.
paggiginnasangasátentayo	let us have them toss up.
paglallalakiénda ni Ana	they tell Ann to wear men's clothes.
ápay ta pagtagibuneñgéndak	why do you make me carry a cutlass?
pagtagilakoém ni Juána	make a saleswoman of Joan.
pinaginsasáñgitda idá	they told them to simulate weeping.
paginpipiláyentayo ni Juán	let us tell John to simulate lameness.
pinagipánda dagití ubbíñg	they told the children to carry it there.
pagirudrenna ti labútab	he foams.

pagipaarábem ni gayyémko	tell my friend to bring (them) to the pasture.
pagpainumém ni Cárlos	tell Charles to water them.
pagpadigúsenyo ni Pédro ití kabáyo	tell Peter to bathe the horse.
pinagpalútomi ti kosinéro	we told the cook to have it cooked.
pinagpaálami ti gayyémmi	we told our friend to have it taken.

2. The infix *um* is changed into the combination *pa. . . en* (past: prefix *pina*). We shall give here a few of the meanings of the ubiquitous *pa*, as we have stated before that the notions of order and permission are far from exclusive. We shall use as example the combination *pa. . . en*, and whatever is said about its different meanings and uses may be supplied, at least partially, wherever we state that a certain combination in *pag* or *pa* implies the notion of order or permission.

The combination *pa. . . en* is used:

a. To order somebody to do something. Examples:

paruárem dagití áso	put the dogs out.
pinapánawmi idá	we sent them away.
paayéntayo ti lakáy	let us tell the old man to come.
pinaadayó ti bakét dagití ubbíñg	the old woman put the children aside.
patakderénda idá ámin	they make them all stand up.
dída pinaimbág	they did not cure them.
pasaduténda dagití ubbíñgda	they make their boys lazy.
parigátenda dagití naganák kadakuáda	they treat their parents hard.
pabanetbetém ti gayyémmo	tell your friend to strike with force.
pañgabaroánem ti biágmo	begin a new life.
pamauyóñgenda ti kabsátda	they make their brother insane.

b. To allow somebody to do something. Examples:

pauliém idá	let them come up.
pasrekénda dagití sañgaíli	they let the strangers come in.
patugawéntayo ti lakáy	let us allow the old man to sit down.
pinainanámi ti masakít	we allowed the sick man to take a rest.
pinaiddáda ti ubíñg ta nabannóg	they allowed the child to lie down as it was tired.
dína pasuñgbáten idá	he does not allow them to answer.

c. To give something to somebody. Examples:

dagití kakabsátko painuménda dagití bakét	my brothers give the old women a drink.
pasosoénda dagití annákda	they give their children the breast.
pinakánmi idá	we fed them.
padigúsen ti ubíñg dagití nuáñg	the boy bathes the carabaos.

d. To allow something to happen. Examples:

paruárem ti búlan	wait till the moon rises.
palennekénda ti ínit	they wait till sunset.
pinasírawmi ti ínit	we waited till sunrise.
pinalábasmi idí kalmán	we saw him pass yesterday.

e. To express one's opinion about somebody or something, and the like; rarely used. Examples:

ápay a dídak padeñggén	do you think I have no ears?
pababúyenmi dagitá	we use those as pigs.
pinaásodatayo	they treated us as dogs.
pamanokéntayo daytá abúyo	let us use that jungle fowl as a domestic cock.

NOTE 14. a. The difference between the combinations *pag . . . en* and *pa . . . en* is the same as that between the prefix *ag* and the infix *um;* the combination *pag . . . en,* from the prefix *ag,* means order, and the like, while the combination *pa . . . en,* from the infix *um,* rather means permission, and the like, or, when it means order it is always of less force and importance or less strict than the order, for example, implied in the combination *pag . . . en.* Examples:

pagtugawém idá	force them to sit down.
patugawém idá	allow them to sit down.
pagdigúsenmi	we force him to bathe.
padigúsenmi	we let him bathe.
pinaginanáyo	you made him rest.
pinainanáyo	you let him rest.
paguráyentayo	let us make him wait.
pauráyentayo	let us make him wait a while.
pagsagádenda	they make him sweep it.
pasagádenda	they make him sweep it a little.

b. To this combination *pa . . . en* belongs also the combination *pakin . . . en,* explained under the substantival prefix *ipa.* Examples:

pakinbabaém ti líbro	put the book underneath.
pinakinláudda ti anákko	they placed my son west of (the others).

3. The prefix *maka* is changed into the combination *paka. . . en* (past: prefix *pinaka*). Examples:

siák ti pakabasólenna	it is I whom he forces to make a mistake.
pinakañgñgégna idá	he made them hear.

4. The prefix *maki* is changed into the combination *paki. . . en* (past: prefix *pinaki*). Examples:

pakiasawáem ni Ana	give Ann in marriage.
pakiintuódek kenká	I tell him to ask you.

5. The prefix *mañg* is changed into the combination *pañg. . . en* (past: *pinañg*).[11] Examples:

pañgaláem ti ubíñg ití págay	tell the boy to take rice.
pinañgbáutdak kenkuána	they made me whip him.
pamatiénna ti kabsátna ití saóna	he makes his brother believe his words.
pinamírokyo ti kaaróbayo ití áso	you made your neighbor look for the dog.
panalusénmi ti gayyémmi ití paraáñgan	we make our friend clean the yard.
pinaninnágko ni Ana ití báñga	I made Ann drop the pot.
pañgaramútentayo ti púsa ití kaádaltayo	let us make the cat scratch our classmate.
pinañgárusda ti lakáy ití lamisáan	they made the old man scrape the table.
paminduáenyo	make him do it twice.
pañgisurátenyo idá	make them write it down.
pañgpadigúsentayo	let us force (him) to bathe (them).

NOTE 14. A few words, especially those extraordinary forms in *mañg*, as *mañgán*, for example, and in *ma*, as *matúrog*, for example, which, if they were ordinary adjectival verbs, should be formed with the prefix *ag* or the infix *um*, generally follow, in this instance, the rules of the same prefix *ag* or infix *um*, and their prefix becomes accordingly *pag* or *pa* with the suffix *en*. Examples:

pakaném ti lakáy	feed the old man.
pinatúrogmi ti ubíñg	we made the child sleep.
pinagpagnáda ti bakét	they made the old woman walk.

C. When the order bears on the object, the prefix *pa* (past: *pina*) is joined to the substantival verb as it is, its prefixes and suffixes remaining intact, except the suffix *en*, which is dropped. These combinations are substantival.

When the simple prefixes or suffixes allow this combination, so do also generally the combinations formed with these simple prefixes or suffixes; so, for example, if the original prefix *i*, which allows this combination (*pai*) is combined with the suffix *an*, the latter combination also allows this form *pai* (*pai. . . an*).

Here follow the most important combinations:

1. The suffix *en* is changed into the prefix *pa* (past: *pina*). Examples:

paálam ti kallogóñgko	send for my hat.
pasápulko ti napúkawna	I have (them) look for what he lost.
pinapárutmi ti róot kadagití ubbíñg	we had the weeds pulled up by the children.

[11] See also the Transitive Prefix *Mañg*. Unpublished.

padáitminto ti bádomi	we shall have a coat made for us.
pasaklóttayo ti ubíñg	let us have the child borne in the lap.
pinatarimáanko ti nadadáel	I had the spoiled things repaired.
pinalpásko kadagitá	I had it finished by those.
paiñgúñgutko	my beloved.
paimbágna ti dákes	he has the bad considered as good.
paapómi ni kabsátmo	we have your brother considered as the master.
paarámidda ti saánmi a kayát	they cause to be made what we do not like.
pasapínna toy lúpot	he has this cloth made into trousers.
pasañgapúlom dagití waló	make the eight ten.
papísosyo	make it a peso.
pinamatmatáda ti panagragáditayo	they did our sawing by sight.
patagikuána ken Pédro	he has it owned by Peter.
pasagduduána idá	he has them distributed two each.

NOTE 15. The substantival prefix *ipa*, explained in another part of this paper, should find its place here, as it is simply a combination of the instrumental prefix *i* with the above prefix *pa*. The difference in form between *ipa* and *pa* obviously consists in the respective presence and absence of the prefix *i*. Although in reality the difference in meaning also depends chiefly on the presence or absence of this particular prefix *i*, in practice it is not always easy to remember the notion of instrumentality connected with the prefix *ipa*. Therefore we give here a further illustration on the subject, so as to enable the student to distinguish easily between the two prefixes *ipa* and *pa*.

Whenever one wants to include in the verb the notion of application, it is necessary to use the prefix *ipa*, else the prefix *pa* should be used.

For example, to say: give water to be drunk, it will be necessary to say: *ipainúmmo ti danúm*, because the water has to be applied to the one who drinks it; but when you want to say: cause water to be drunk, as there is no notion of application included in this sentence, it will be necessary to say: *painúmmo ti danúm*.

And so also: *ipakánmo ti págay*, give rice to be eaten; but: *pakánmo ti pagáy*, have rice eaten.

These differences are obviously more or less theoretical, but in the following examples the importance of knowing very well the difference between the two, will be very clear and patent: *ipabóoñgmo kenkuána:* accuse him of breaking it; *pabóoñgmo kenkuána:* make him break it; *ipatákawko ken Juán ti pirák ti apók:* I accuse John of stealing the money of my master; *patákawko ken Juán ti pirák ti apók:* I tell John to steal the money of my master.

2. The suffix *an* is changed into the combination *pa. . . an* (past: *pina. . . an*). Examples:

pinaasinák ti digó	I had the broth salted.
paraepák ti tálonko	I have my rice field planted.
paayabánmi ni Juán	we have John called.
pinatulóñganda ti gayyémda	they had their friend helped.
paluktántayo ti táwa	let us have the window opened.

pinakariánda ti gayyémko	they had my friend obliged to promise.
paotoñgányo ti bañgkágyo	have cowpeas sown in your field.
pinasiloánda ti ásomi	they had our dog ensnared.
pinanayónanmi	we had it augmented.
pakartíbantayo daytóy	let us have a part of this cut off.
pasibugányo dagití múla	have the plants watered.
paugásanna dagití piñggán	he has the dishes washed.
pinadalusánna ti báñga	he had the pot cleaned.
pinasukatánna ti danúmna	he had its water changed.
pinautáñganna	he had it borrowed.
padalapúsanda	they have them jostled.
panagánantay ti ubíñg	let us have the child named.
padawátantayo ti lakáy	let us have the old man ask for it.
pakissayánda	they have it diminished.
pinakawesán ni Juána ti duá a napañgláw	Joan had two poor persons clothed. t

NOTE 16. This combination is also used with names of parts of the body, and means: to attach a person or an animal by that part of his body which is indicated by the stem. Examples:

patakiáganda ti anákda	they attach their child by the arm.
pinasakáanda ti nuáñg	they attached the carabao by the leg.
pasikétantay idá	let us attach them by the waist.
pateñgñgedám ta áso	attach that dog by the neck.
paluppoándakami	they attach us by the thigh.

3. The prefix *i* is changed into the complex prefix *pai* (past: *pinai*). Examples:

paipányo daytá	have that carried there.
pinayégmi ditóy	we had it brought here.
pinayúlida ti págay	they had the rice brought in.
pairuármo	have it taken out.
paikastóyyo	have it done this way.
paibabáda	they have it brought down.
pinaitúgotmi ken Juán	we told John to take it with him.
pinaibúlosmi	we had it loosened.
paipalúbosmo daytá	have that permitted.
paigátañgko ti manók	I have it bought with a chicken.
paibílinmi	we have it ordered.
paibítin ti agturáy	the rulers have it hung up.
paiditóy ni Ana dagití abél	Ann has the clothes placed here.
paisrék ni kabsátko ti nayég a págay	my brother has the rice, which was brought, put inside.
paidaítanda ni Juána ti bádona	they have a coat made for Joan.
paibayoánmi ni Pédro	we have people pound rice for Peter.
pinayaramídannakami ti baláy	he had a house made for us.
paipakaammóda kadagití kakabsátna	they have it announced to his brothers.

4. The prefix *ipa* is changed into the complex prefix *paipa* (past: *pinaipa*). Examples:

paipadáyayo	have it put eastward.
pinaipañgátoda	they had it put upward.
pinaipakánmi ti págay ití kabáyo	we had rice fed to the horse.
paipagtéñgmi kadakayó	we have it brought toward you.
paipapúñganmo ti bató	have the stone used as a pillow.
paipainúmmo daytá árak	cause that wine to be given to drink.
paipatagudínmo	have it brought toward Tagudin.
pinaipaabagátan ni Juán dagití báka	John had the cows brought southward.

5. The combinations *pi. . . en* and *pin. . . en,* and the complex prefixes *ipi* and *ipin, ikapi* and *ikapin,* are changed into the complex prefixes *papi* (past: *pinapi*) and *papin* (past: *pinapin*), *paipi* (past: *pinaipi*) and *paipin* (past: *pinaipin*), *paikapi* (past: *pinaikapi*) and *paikapin* (past: *pinaikapin*), respectively. Examples:

papiduám	have it done twice.
papinpátda toy panagtaráyna	they have this running of his done four times.
pinaipinpitóda	they had it done seven times.
pinaipitlóda	they had it done three times.
paikapitlóm	have it done for the third time.
pinaikapinwalóna	he had it done for the eighth time.

D. The construction in which the prefix *pa* is combined with the prefixes and suffixes of the substantival voice may become adjectival, and in this case the verb obtains a reflexive meaning, and the order or permission bears on the subject of this adjectival verb. Examples:

paubíñgka	offer your services as a servant.
pasaplítkami kenkuána	we have ourselves beaten by him.
saánka komá a paábak ití dákes	do not let yourself be overcome by evil.
saának ñga umáy paawít kadakayó	I do not come to have myself carried by you.
paasáwaka	offer yourself in marriage.
madadáanak a pabílin kenká	I am ready to let myself be ordered by you.
patpatúrog a pagan-anáy	nightgowns.
pabigbígka a siká ti okóm	let yourself be considered as the judge.
duá a pababáon	two servants (to be sent).
pinabilbílinak	I became a servant.
pinatilíwkayo	you let yourselves be caught.

patartarakénkami	we have ourselves brought up (by others).
pabuniágankayo kenkuána	have yourselves baptized by him.
díka pauyótan kadakuáda	do not let yourself be coaxed by them.
pabantáyanak ta dákes ti ugálik	I have myself watched because I have bad habits.
umáyda paisalákan	they come to have themselves saved.
díka paikáwa ken ladíñgit	do not let yourself be broken down by grief.
paidurón dagitá	those have themselves pushed.
paikúyogak kenká	I let you take me with you.
paiturayánkayto	you will let yourselves be ruled.
paipalnédka	have yourself disappear.
paipaárab dagití nuáñg	the carabaos have themselves brought to the pasture.

III. As may be seen in the preceding explanations, the past form of the combination *pa. . . en,* from the adjectival infix, *um,* is the same as that of the prefix *pa,* from the substantival suffix *en.* Both past forms allow the same prefix *pina,* so that confusion might arise in their use. To illustrate these two combinations, and at the same time to show clearly the difference between the four combinations where the prefix *pa* enters, and between the different ways how order or permission may be expressed, we shall give the following example about a man beating a boy by order of myself.

1. Sentences without any notion of order or permission:

a. Adjectival prefix *ag:*

agbáut ti táo: the man beats.

Adjectival infix *um:*

bumáut ti táo: the man beats.

b. Substantival suffix *en:*

baúten ti táo tí ubíñg: the man beats the boy.

2. Sentences with the notion of order or permission.

A. Bearing on the action (adjectival):

(a) *agpabáutak:* I order beating.

B. Bearing on the subject of the adjectival verb, the man (substantival):

(a) (*ag*) *pagbaútek ti táo ití ubíñg:* I tell the man to beat the boy. (*um*) *pabaútek ti táo ití ubíñg:* I tell the man to beat the boy. (past) *Pinabáutko ti táo ití ubíñg:* I told the man to beat the boy.

C. Bearing on the object of the substantival verb, the boy (substantival):

(b) *pabáutko ti ubíñg ití táo:* I have the boy beaten by the man. (past) *Pinabáutko ti ubíng ití táo:* I had the boy beaten by the man.

D. Bearing reflexively on the subject of the adjectival verb:

(b) *pabáut ti táo:* the man lets himself be beaten. (past *pinabáut ti táo:* the man let himself be beaten. *pabáut ti ubíñg ití táo:* the boy lets himself be beaten by the man. *pabáutak;* I let myself be beaten.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XLI

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

FOUR PLATES

The present report is based on extensive collections of crane flies that were secured in northern Korea (Chosen) by Mr. Alexander Yankovsky. The general conditions under which these collections were made have been discussed in connection with the preceding report under this general title.[1] In 1938 Mr. Yankovsky made very extensive collections at various altitudes in the Seren Mountains, and many of the most interesting species herein described were then taken. I am very greatly indebted to Mr. Yankovsky for his continued interest in collecting these flies. The types of all novelties are preserved in my private collection of the Tipulidæ.

LIMONINÆ

LIMONIINI

LIMONIA (LIMONIA) PARVIPENNIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Allied to *tanakai;* wings very small but not at all degenerate nor with distorted venation; general coloration of thorax yellow, unmarked; antennal flagellum dark brown to black; halteres uniformly pale yellow; femora yellow, tips narrowly but conspicuously blackened; wings brownish yellow, sparsely patterned with darker; m-cu at fork of M; abdomen elongate, caudal borders of second to seventh segments, inclusive, conspicuously banded with brown; terminal two segments uniformly black; ninth tergite of male hypopygium without rounded lateral lobes.

Male.—Length, about 8 millimeters; wing, 5.

Rostrum and palpi black. Antennæ with scape and pedicel obscure yellow; flagellum dark brown to black; flagellar segments oval to long-oval, verticils elongate. Head obscure yellow,

[1] Philip. Journ. Sci. 67 (1938) 129–166.

center of vertex infuscated; anterior vertex wide, approximately two times diameter of scape.

Pronotum brownish black, paling to yellow on sides. Mesonotum and pleura uniformly polished yellow, unmarked. Halteres uniformly pale yellow. Legs yellow; tips of femora narrowly but conspicuously blackened, the amount equal on all legs; tibiæ more obscure yellow, tips very narrowly darkened; basitarsi passing through obscure yellow to black; remainder of tarsi black. Wings (Plate 1, fig. 1) unusually small as compared to length of body, much shorter than abdomen but not at all distorted in shape or venation; ground color brownish yellow, prearcular and costal fields clearer yellow; stigma suboval, medium brown; very restricted brown seams at origin of Rs, fork of Sc, cord and outer end of cell 1st M_2; a vague dusky wash in cell R; veins pale brown, more luteous in yellow areas. Venation: Sc moderately long, Sc_1 ending shortly before midlength of Rs, Sc_2 longer, ending opposite this point; Rs long, arcuated; cell 1st M_2 about as long as vein M_4 beyond it; m-cu at or close to fork of M; anal veins divergent.

Abdomen unusually long and conspicuous, segments correspondingly lengthened; yellow, caudal borders of second to seventh segments, inclusive, conspicuously brown; eighth segment and hypopygium black. Male hypopygium (Plate 2, fig. 25) with caudal margin of tergite, *9t*, with a broad U-shaped notch. Ventromesal lobe of basistyle very low to scarcely developed; setæ lacking on cephalic portion of basistyle. Dististyle, *d*, entirely black, broad at base, narrowest just beyond midlength, apex narrowed and prolonged, tip obtuse. Gonapophyses, *g*, with mesal apical lobe long and spinelike, terminating in an acute pale spike, surface back from apex with conspicuous setæ. Ædeagus, *a*, broad at base, terminating in two parallel, recurved spines.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 4,000 feet, July 10, 1938 (*Yankovsky*).

This curious fly is most closely related to *Limonia* (*Limonia*) *tanakai* (Alexander), having the same peculiar type of hypopygium; that is, a single dististyle constricted at near midlength, spinous hairy mesal-apical lobes of gonapophyses, and paired recurved apical spines of ædeagus. The present fly differs conspicuously in several important features, notably the brown

antennal flagellum, unusually small wings and correspondingly lengthened abdomen, m-cu at the fork of M, banded abdominal segments, and in the details of structure of the male hypopygium, as the less extended and expanded apices of the dististyles and the lack of obtusely rounded tergal lobes. The grotesquely small wings and lengthened abdomen give this insect a very peculiar appearance.

LIMONIA (DICRANOMYIA) PARVILOBA sp. nov. Plate 1, fig. 2; Plate 2, fig. 26.

Belongs to the *morio* group and subgroup; male hypopygium with tergal lobes moderately long, separated by a broad notch; basistyle with ventromesal lobe small; dorsal dististyle acute at tip; gonapophyses simple, mesal-apical lobes terminating in subacute to weakly bidentate points.

Male.—Length, about 5 to 5.5 millimeters; wing, 5.8 to 6.5.

Female.—Length, about 6 to 6.5 millimeters; wing, 6 to 7.

Rostrum and palpi black. Antennæ black throughout; flagellar segments passing through oval to long-oval; terminal segment subequal to penultimate. Head with front and broad anterior vertex silvery; posterior part of head black.

Thorax polished black, pleura a little more gray-pruinose. Halteres with stem obscure yellow, knob brownish black. Legs with coxæ black, posterior pair more reddish; trochanters yellow; fore femora black, only narrow bases obscure yellow; remaining femora yellow, tips passing into black, narrowest on posterior pair; tibiæ and tarsi obscure yellow, outer tarsal segments darkened. Wings (Plate 1, fig. 2) with a brownish-yellow tinge, prearcular field clearer yellow; stigma small, brown; veins brown. Venation: Sc ending approximately opposite origin of Rs, Sc_2 some distance from its tip; m-cu close to fork of M.

Abdomen black, intermediate segments broadly ringed with reddish; hypopygium black. Male hypopygium (Plate 2, fig. 26) with tergal lobes, *9t*, moderately long, separated by a broad notch that is usually wider than long, in cases with breadth and length subequal. Ventromesal lobe of basistyle, *b*, small, with coarse marginal setæ. Dorsal dististyle, *dd*, acute at tip. Ventral dististyle, *vd*, profoundly divided, as in subgroup; rostrum elongate. Gonapophyses, *g*, simple, mesal-apical lobe terminating in subacute or weakly bidentate points. Ædeagus, *a*, broad, nearly parallel-sided, lateral margins with delicate setulæ, apex abruptly narrowed and set off by square shoulders.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 4,000 feet, July 10, 1938 (*Yankovsky*). Allotopotype, female, altitude 3,000 feet, July 10, 1938. Paratopotypes, 5 males and females, altitude 3,000 to 4,500 feet, June 30 to July 19, 1938; paratypes, males and females, Ompo, altitude 200 to 500 feet, May 28 to June 9, 1938.

This is the first member of the *morio* subgroup discovered in eastern Asia. Among the described species, including the Nearctic *Limonia* (*Dicranomyia*) *nycteris* (Alexander) and the western Palæarctic *L.* (*D.*) *caledonica* (Edwards), *L.* (*D.*) *morio* (Fabricius), and *L.* (*D.*) *stylifera* (Lackschewitz), the present fly is closest to *caledonica,* differing especially in the hypopygial features, such as the unusually small lobe of the basistyle and the structure of the gonapophyses.

LIMONIA (DICRANOMYIA) PARVILOBA PARVINCISA subsp. nov. Plate 2, fig. 27.

Differs from the typical form in the structure of the male hypopygium (Plate 2, fig. 27) : notch of ninth tergite, 9*t*, small, subcircular in outline. Gonapophyses, *g*, with mesal-apical lobe obtuse at tip.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 200 feet, May 28, 1938 (*Yankovsky*).

Allotopotype, female. Paratopotype, male.

LIMONIA (DICRANOMYIA) IMMODESTOIDES (Alexander).

Dicranomyia immodestoides ALEXANDER, Ann. Ent. Soc. America **12** (1919) 327, 328.

Northern Korea, Seren Mountains, altitude 5,000 feet, September 15, 1938 (*Yankovsky*).

LIMONIA (DICRANOMYIA) TRISTIS (Schummel).

Limnobia tristis SCHUMMEL, Beitr. zur Entomol. (1829) 135.

Northern Korea, Seren Mountains, altitude 3,000 feet, June 15, 1938 (*Yankovsky*). Very similar to typical material from central Europe. The only difference is that in the male hypopygium of the present fly the most cephalic tubercle on mesal face of basistyle is slightly longer than in European specimens.

ANTOCHA (ANTOCHA) BIFIDA Alexander.

Antocha (*Antocha*) *bifida* ALEXANDER, Philip. Journ. Sci. **24** (1924) 564–566.

Northern Korea, Seren Mountains, altitude 3,000 feet, June 30, 1938 (*Yankovsky*).

ANTOCHA (ANTOCHA) INTEGRA sp. nov. Plate 1, fig. 3; Plate 2, fig. 28.

General coloration ocherous, præscutum darkened medially in front; antennal flagellum black; head light gray; halteres with stem pale, knob dark brown; legs long and conspicuous, femora black, with bases restrictedly brightened; wings whitish subhyaline, prearcular field milky white, stigma scarcely differentiated; veins brown, conspicuous against ground; male hypopygium with outer dististyle dilated at apex into a blade, its margin scarcely or but feebly emarginate; ædeagus with subtending apical lobes very pale and hyaline.

Male.—Length, about 6 millimeters; wing, 6.5.

Rostrum yellow; palpi black. Antennæ short; scape and pedicel yellow above, darker beneath; flagellum black; flagellar segments oval, clothed with a conspicuous white pubescence. Head light gray.

Pronotum infuscated medially, yellow on sides. Mesonotum ocherous; præscutum darkened medially in front and in vicinity of pseudosutural foveæ, virtually immaculate behind. Pleura yellow, anepisternum and sternopleurite somewhat more darkened. Halteres with stem pale, knob dark brown. Legs with coxæ testaceous yellow, fore pair darker; trochanters yellow; legs long and conspicuous, femora black, only bases restrictedly brightened; tibiæ and basitarsi light brown, outer tarsal segments dark brown; claws with a single, very slender, subbasal spine. Wings (Plate 1, fig. 3) whitish subhyaline, prearcular field more milky white; stigma scarcely differentiated, pale; veins brown, conspicuous against ground, whitened in prearcular field. Venation: Rs long but still somewhat shorter than in *brevistyla;* cell 1st M_2 more pointed at proximal end.

Abdomen light brown; subterminal segments dark brown; hypopygium brownish yellow. Male hypopygium (Plate 2, fig. 28) with basistyle, *b,* at proximal end on mesal face produced into a small setiferous lobe. Outer dististyle, *od,* strongly curved, at apex dilated into a long triangular head, apex obliquely truncated to very feebly notched, not conspicuously emarginate, as in *brevistyla.* Inner dististyle, *id,* strongly curved, a little dilated on outer half, provided with abundant setæ. Ædeagus, *a,* with subtending apical lobes very pale and hyaline, not appearing as sclerotized oval lobes, as in *brevistyla.*

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 800 feet, July 13, 1938 (*Yankovsky*).

Antocha (*Antocha*) *integra* is most nearly allied to *A.* (*A.*) *brevistyla* Alexander and *A.* (*A.*) *sagana* Alexander, agreeing in the general conformation of the dististyles and in the presence of a small setiferous lobe on the mesal face of basistyle. It appears to be closest to *brevistyla,* especially in the long conspicuous legs and the distinct wing veins, differing in the details of structure of the male hypopygium, especially the simple apical blade of the outer dististyle and the feebly sclerotized outer lateral lobes of the ædeagus. *A.* (*A.*) *sagana* is much smaller, with pale wing veins that are ill-defined against the ground, and with the details of structure of the male hypopygium distinct.

PEDICIINI

PEDICIA (NASITERNELLA) HOKKAIDENSIS Alexander.

Pedicia (*Nasiternella*) *hokkaidensis* ALEXANDER, Philip. Journ. Sci. 53 (1934) 278, 279.

Northern Korea: Seren Mountains, altitude 3,000 to 4,500 feet, June 17 to 30, 1938 (*Yankovsky*). It seems virtually assured that both *hokkaidensis* and the Neartic *hyperborea* (Osten Sacken) will prove to represent at most geographical races of *variinervis* (Zetterstedt).

DICRANOTA (EUDICRANOTA) PERDISTINCTA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

General coloration pale yellow; halteres elongate; wings pale yellow, very restrictedly patterned with brown on crossveins and deflections; a supernumerary crossvein in cell R_1; Rs angulated to square at origin; cell R_4 long-petiolate, petiole a little more than one-third length of cell; cell 1st M_2 closed; cell M_1 long-petiolate; male hypopygium with dististyle at apex bearing numerous blackened peglike spines.

Male.—Length, about 6 to 7 millimeters; wing, 6 to 7.5; antenna, about 1.

Female.—Length, about 5.5 millimeters; wing, 5.

Rostrum obscure yellow; palpi pale brown. Antennæ yellow, outer flagellar segments weakly infuscated; antennæ 12- to 14-segmented, basal two or three flagellar segments crowded, with ill-defined sutures; outer segments oval, terminal segment smaller than penultimate. Head pale yellow.

Thorax uniformly pale yellow, notum dusted with whitish. Halteres elongate, pale yellow. Legs yellow, tips of femora narrowly and weakly infuscated, tips of tibiæ still more narrowly blackened; tarsi yellow, tips of individual segments narrowly darkened, outer segments uniformly infuscated. In female

femoral tips undarkened. Wings (Plate 1, fig. 4) with a pale yellow tinge, very restrictedly patterned with brown, appearing as narrow seams at origin of Rs, Sc_2, cord, outer end of cell 1st M_2, R_2, and supernumerary crossvein in cell R_1; veins pale yellow, darkened in clouded areas. Venation: Sc_1 ending opposite or shortly before supernumerary crossvein in cell R_1; Sc_2 at near middistance between arculus and origin of Rs; Rs angulated to square at origin, in cases short-spurred; R_2 oblique, fusion with R_1 very short; supernumerary crossvein in cell R_1 variable in position, usually just before level of fork of R_{4+5}; cell R_4 with petiole a little more than one-third length of cell; cell 1st M_2 closed, with m-cu at or very close to fork of M; petiole of cell M_1 long, from one and one-half to twice length of cell.

Abdomen obscure yellow. Male hypopygium (Plate 2, fig. 29) with dististyle, *d*, single, pale, expanded outwardly, truncated apex set with numerous peglike spines. Basistyle, *b*, long; interbasal rod pale, broad at base, narrowed into a long sinuous point. What appear to represent extensions of the tergite, *9t*, are evidently stouter and more powerful submedian horns that gradually narrow to very pale acute points, the expanded subbasal portions with several pale punctures.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 200 feet, May 24, 1938 (*Yankovsky*).

Allotopotype, female, altitude 700 feet, June 9, 1938. Paratopotypes, 3 males, altitude 300 to 700 feet, May 28 to June 9, 1938 (*Yankovsky*).

The present fly is well-distinguished from the two species of *Eudicranota* hitherto described, *D.* (*E.*) *notabilis* Alexander and *D.* (*E.*) *pallida* Alexander, of eastern North America, by the venation, especially the long petioles of cells R_4 and M_1. In the Asiatic fauna the fly is entirely different from all other known species of *Dicranota.*

DICRANOTA (DICRANOTA) YEZOENSIS COREANA subsp. nov.

Female.—Length, about 7 millimeters; wing, 8.

Close to typical form. Antennæ 13-segmented; flagellar segments oval, first a little less than twice second; third segment a little smaller than penultimate. Mesonotal præscutum with median stripe virtually entire, with a scarcely evident pale median vitta. Wings with venation much as in *yezoensis;* Sc_2 closer to origin of Rs, distance about three-fourths R alone;

petiole of cell R_3 very short, less than basal section of R_5; cell M_3 deeper, M_{3+4} and M_4 subequal. Macrotrichia of veins shorter. Abdominal segments uniformly brownish black, caudal borders not pale.

Habitat.—Northern Korea.

Holotype, female, Seren Mountains, altitude 2,800 feet, June 15, 1938 (*Yankovsky*).

HEXATOMINI

LIMNOPHILA (ELÆOPHILA) PERSALSA sp. nov. Plate 1, fig. 5; Plate 2, fig. 30.

General coloration dark brownish gray, præscutum with four ill-defined darker brown stripes on posterior half; basal flagellar segments pale; halteres pale yellow; legs yellow, tips of femora narrowly but abruptly black; wings broad, pale cream-yellow, heavily patterned with brown, areas confined to vicinity of veins; male hypopygium with outer dististyle relatively broad, terminating in a slender appressed spine, outer margin on distal half with microscopic teeth.

Male.—Length, about 6.5 to 7.5 millimeters; wing, 7 to 8.

Female.—Length, about 7 millimeters; wing, 7.5.

Rostrum black, pruinose, palpi black. Antennæ with scape and pedicel black; basal two or three flagellar segments yellow, remaining segments passing into brown; flagellar segments long-oval, with conspicuous verticils. Head gray.

Pronotum and mesonotum dark brownish gray, præscutum with four ill-defined darker brown stripes on posterior half, obliterated on anterior portion; pseudosutural foveæ black. Pleura dark brownish gray. Halteres pale yellow. Legs with coxæ light brown, fore pair darker; trochanters obscure yellow; femora yellow, tips narrowly but abruptly blackened, the amount subequal on all legs; tibiæ pale yellow, tips very narrowly darkened; tarsi pale yellow, outer two segments blackened. Wings (Plate 1, fig. 5) broad; ground color pale cream-yellow, heavily patterned with solid dark-brown areas that are restricted to vicinity of veins, including a larger costal series at h, origin of Rs, fork of Sc, and stigma and tips of veins R_3 and R_4; dark area at origin of Rs in transverse alignment with other major darkenings at supernumerary cross-vein in cell M and at tip of vein 2d A, forming an almost complete band at this point; no dark marking basad of this band in cell 2d A; other, more restricted, dark areas at cord, outer end of cell 1st M_2, fork of M_{1+2}, and as marginal clouds at ends of longitudinal veins; veins yellow, darker in clouded

areas. Venation: R_{2+3+4} long, in direct alignment with Rs; R_2 beyond fork of R_{2+3+4}, subequal to R_{2+3}; cell 1st M_2 narrow, with m-cu at near one-third length; supernumerary crossvein in cell M opposite or just before origin of Rs.

Abdomen dark brown, caudal borders of segments still darker; hypopygium dark brown. Male hypopygium (Plate 2, fig. 30) with outer dististyle, *od*, relatively broad, terminating in a slender appressed spine; outer margin on distal half with microscopic teeth, most basal one not or only slightly larger; inner margin on outer third microscopically crenulate or with small obtuse teeth. Inner dististyle entirely pale.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,700 feet, June 30, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, 5 males, altitude 3,000 to 3,700 feet, June 17 to July 5, 1938 (*Yankovsky*).

Limnophila (*Elæophila*) *persalsa* is quite distinct from the other regional species of the subgenus. The broad cream-yellow wings, with markings restricted to the vicinity of the veins, and the structure of the male hypopygium, especially of the outer dististyle, furnish strong specific characters.

LIMNOPHILA (ELÆOPHILA) SERENENSIS sp. nov. Plate 1, fig. 6; Plate 2, fig. 31.

General coloration brownish gray, præscutum with four brown marks; antennæ short, brownish black throughout; mediotergite gray, posterior border broadly dark brown; femora yellow, tips conspicuously and abruptly blackened; wings whitish subhyaline, with certain cells washed with darker; a conspicuous darker-brown pattern that is confined to vicinity of veins; wings relatively narrow; male hypopygium with lateral spine of outer dististyle appressed.

Male.—Length, about 6 millimeters; wing, 6.6.

Rostrum and palpi black. Antennæ brownish black throughout, relatively short, if bent backward scarcely attaining wing root. Head gray.

Mesonotal præscutum brownish gray, intermediate stripes a little darker, especially two linear dashes at posterior ends; a circular brown spot on either side of intermediate stripes, nearly opposite black pseudosutural foveæ; posterior sclerites of mesonotum dark gray, centers of scutal lobes a little darker; posterior border of mediotergite broadly dark brown. Pleura gray, variegated with dark-brown spots. Halteres pale yellow. Legs with coxæ brown; trochanters brownish

yellow; femora yellow, tips conspicuously and abruptly black, the amount subequal on all legs; tibiæ yellow, tips narrowly dark brown; tarsi yellow, terminal segments darker. Wings (Plate 1, fig. 6) whitish subhyaline; certain cells, especially M, Cu, bases of anal cells, and along vein R_5, weakly infumed; a conspicuous darker-brown pattern that is restricted to vicinity of veins, including a series of about seven costal areas, smallest at h, largest at origin of Rs, fork of Sc, and stigma; narrower seams along cord, outer end of cell 1st M_2, supernumerary crossvein in cell M, and fork of M_{1+2}; a marginal series of small spots at ends of veins M_1 to 2d A, inclusive; no dark spot basad of cloud at end of vein 2d A; veins yellow, dark in clouded areas. Wings relatively narrow, not dilated in male. Venation: Cell 1st M_2 relatively small.

Abdominal tergites dark brown, sparsely pruinose; basal portions of sternites variegated by obscure yellow; hypopygium brownish yellow. Male hypopygium (Plate 2, fig. 31) with basistyle, *b*, slender. Outer dististyle, *od*, generally smooth, except at apex; lateral spine appressed; apical spine slender, with microscopic spinulæ back from base.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 4,000 feet, October 9, 1937 (*Yankovsky*).

Limnophila (*Elæophila*) *serenensis* is most similar to *L.* (*E.*) *subaprilina* Alexander, of Japan, agreeing in the general nature of the wing pattern, with all dark areas confined to the vicinity of the veins and without interpolated dots in the interspaces as in the majority of the species in Asia. It differs in the abruptly blackened femoral tips, the pattern of the thorax, and the details of the wing pattern, as the lack of a supplementary dark cloud in cell 2d A. In the European fauna both *L.* (*E.*) *maculata* (*Meigen*) and *L.* (*E.*) *submarmorata* Verrall show an unusual range of color forms that have been treated as varieties by Edwards.[2]

LIMNOPHILA (ELÆOPHILA) SUBAPRILINA YEZOENSIS Alexander.

Northern Korea, Seren Mountains, altitude 2,000 to 4,000 feet, August 8, 1938 (*Yankovsky*). As in typical *subaprilina*, the present fly has a major darkened cloud in cells 1st A and 2d A, lying proximad of the smaller dark area at end of vein 2d A.

[2] Trans. Soc. Brit. Ent. pt. 1 5 (1938) 1–168, 5 pls., 31 figs.

LIMNOPHILA (ADELPHOMYIA) MACROTRICHIATA Alexander. Plate 1, fig. 7.

Limnophila (*Lasiomastix*) *macrotrichiata* ALEXANDER, Ann. Ent. Soc. America 16 (1923) 65, 66.

Northern Korea, Ompo, altitude 300 to 500 feet, June 15 to 23, 1937; May 20 to 29, 1938 (*Yankovsky*). In these specimens the lower lobe of the inner dististyle of the male hypopygium is proportionately a little shorter than the outer lobe than in the holotype specimen (Teshio, Kokkaido, Japan). The wing venation is shown in Plate 1, fig. 7.

LIMNOPHILA (PRIONOLABIS) ACANTHOPHORA Alexander.

Limnophila (*Prionolabis*) *acanthophora* ALEXANDER, Philip. Journ. Sci. 67 (1938) 157, 158.

Described from a single male specimen. Numerous further specimens, Seren Mountains, altitude 2,000 to 3,800 feet, June 25 to 30, 1938 (*Yankovsky*). Some male specimens are much smaller than the type (Male, length, about 6.5 to 7.5 millimeters; wing, 8.5 to 9) but are undoubtedly conspecific. The single female specimen taken indicates that this sex is subapterous, as is likewise the case in *L.* (*P.*) *imanishii* Alexander, *L.* (*P.*) *luteibasalis* Alexander, and *L.* (*P.*) *nigrilunæ* Tokunaga, all of the main island of Japan. The present fly differs from these others in the relatively larger wings, with accompanying differences in pattern venation.

Female.—Length, about 10 millimeters; wing, 3.5 by 0.7.

Antennæ 16-segmented, dark throughout; basal flagellar segments short, outer segments elongate and comparatively slender; outer three segments subequal. Head black, sparsely pruinose, more heavily so in front. Mesonotum black, surface subnitidous; pleura more heavily pruinose. Halteres broken. Legs with coxæ and trochanters black; remainder of legs black, femoral bases restrictedly yellow. Wings subatrophied, relatively narrow, as shown by the measurements, yet much larger than in other regional species having subapterous females; wings strongly yellow, slightly more brownish yellow outwardly; veins yellow, beyond cord darker and with long coarse setæ; costal fringe unusually long and dense, except at base where setæ are short, pale, and subappressed; costal fringe extending to beyond wing tip. Venation agreeing approximately with that of male but reduced, due to the shape and size of the wings. Abdomen opaque black; ovipositor with elongate valves; cerci brown; hypovalvæ black, more intense basally.

35101——4

Allotype, female, Ompo, northern Korea, altitude 200 feet, May 29, 1938 (*Yankovsky*).

LIMNOPHILA YANKOVSKYANA sp. nov. Plate 1, fig. 8; Plate 2, fig. 32.

General coloration polished black; antennæ (male) very long, nearly as long as body; femora black, extreme bases paler; tibiæ brown, tips black; wings brownish yellow, sparsely patterned with brown; cell R_3 sessile or very short-petiolate; cell M_1 lacking; male hypopygium with outer dististyle blackened, profoundly split into two unequal acute spines.

Male.—Length, about 6.5 to 7 millimeters; wing, 7.2 to 8; antennæ, about 6 to 6.2.

Rostrum and palpi black. Antennæ black throughout, elongate, as shown by the measurements, being only a little shorter than entire body; flagellar segments cylindrical, very long; intermediate segments subequal, outer segments gradually shorter; terminal segment about one-third length of penultimate; flagellar segments with abundant, coarse, erect setæ and slightly longer subbasal verticils. Head dull black; anterior vertex wide, approximately three times diameter of scape; anterior vertex with a low tubercle.

Thorax uniformly polished black; præscutal setæ relatively short and small. Halteres with stem obscure whitish, knobs weakly darkened. Legs with coxæ black; trochanters brownish black; femora black, only extreme bases paler; tibiæ brown, tips blackened; tarsi black. Wings (Plate 1, fig. 8) brownish yellow, a little more yellowish on basal and costal portions; stigma oval, pale brown; barely evident dark seams on cord and along outer end of cell 1st M_2; veins brown, a little brighter in costal and prearcular fields. Venation: Sc_1 ending shortly before fork of Rs, Sc_2 at its tip, subequal; cell R_3 usually sessile, so Rs is in direct alignment with R_4; in cases with a very short petiole, R_{2+3+4}; cell M_1 lacking; m shorter than basal section of M_3, sometimes very short; m-cu variable in position, usually close to midlength of cell 1st M_2, in other cases a little before or beyond.

Abdomen, including hypopygium, shiny black. Male hypopygium (Plate 2, fig. 32) with outer dististyle, *od,* blackened, deeply and unequally divided into two long, acute spines, outer spine shorter, apex microscopically tuberculate; inner spine stout. Inner dististyle, *id,* simple, stout and fleshy, narrow tip obtusely rounded.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 5,000 feet, July 10, 1938 (*Yankovsky*). Paratopotypes, 6 males, altitude 2,500 to 5,000 feet, July 3 to 19, 1938 (*Yankovsky*).

I take great pleasure in naming this very distinct fly in honor of the collector, Mr. Alexander Yankovsky, who has added vastly to our knowledge of the tipulid fauna of northern Korea. The general appearance of the fly is much like that of a *Prionolabis*, but I hesitate to refer it to this subgenus. It is very different from all other known species in eastern Asia. The western Palæarctic *Limnophila longeantennata* Strobl has somewhat similarly lengthened antennæ but is otherwise entirely different.

ERIOPTERINI

RHABDOMASTIX (SACANDAGA) NIGROAPICATA sp. nov. Plate 3, fig. 33.

Male.—Length, about 5 to 5.5 millimeters; wing, 6 to 6.5; antennæ, about 1.2.

Female.—Length, about 5.5 to 7.5 millimeters; wing, 6 to 8.

Generally similar to *R.* (*S.*) *japonica* Alexander, differing chiefly in the coloration of the legs. Compared with *japonica* the following distinctions are present: Median præscutal stripes distinct, darkened in front, usually entire and with surface faintly nitidous; in occasional specimens median stripe split by a narrow pale median line. Flagellar segments longer, with very long conspicuous verticils. Tips of femora conspicuously blackened, bases and tips of tibiæ more narrowly so; tarsal segments beyond basitarsi passing into brown. Abdominal tergites uniformly yellowish brown to pale brown.

In *japonica* four separate præscutal stripes, surface opaque. Tips of femora and bases and tips of tibiæ not or scarcely darkened. Abdominal tergites weakly bicolored, bases darker than outer portions.

Wings with Sc long, Sc_1 ending about opposite four-fifths length of Rs, Sc_2 some distance from its tip, Sc_1 alone exceeding m-cu; R_3 suberect; R_{2+3+4} and R_4 subequal in length; distance on costa between tips of R_{1+2} and R_3 subequal to length of latter; m-cu close to midlength of cell 1st M_2. No macrotrichia on R_3; a complete series of trichia on R_4 and usually one or two on distal portion of R_{2+3+4}. Male hypopygium (Plate 3, fig. 33) with outer dististyle, *od*, relatively stout, pale, almost parallel-sided, outer face with numerous

appressed spines, apex a strongly retrose point. Inner dististyle, *id*, short and stout, narrowed to blunt apex. Gonapophyses, *g*, with apical blade moderately dilated.

Habitat.—Northern Korea.

Holotype, male Seren Mountains, altitude 2,500 feet, June 30, 1938 (*Yankovsky*). Allotopotype, female, altitude 4,000 feet, July 10, 1938. Paratopotypes, males and females, altitude 1,800 to 4,000 feet, June 26 to July 10, 1938.

I am not familiar with the male sex of *Rhabdomastix japonica* and so cannot compare the hypopygial characters.

RHABDOMASTIX (SACANDAGA) USURIENSIS Alexander.

Rhabdomastix (*Sacandaga*) *usuriensis* ALEXANDER, Proc. U. S. N. M. Art. 4 68 (1925) 13.

Described from eastern Siberia. Northern Korea, Ompo, altitude 200 feet, May 25 to June, 3, 1938; Seren Mountains, altitude 3,000 to 3,500 feet, June 17 to July 3, 1938 (*Yankovsky*).

RHABDOMASTIX (SACANDAGA) SPATULIFERA sp. nov. Plate 1, fig. 9; Plate 3, fig. 34.

General coloration dark gray, præscutum without distinct stripes; halteres pale yellow; femora obscure yellow, tips darkened, most extensively so on forelegs; wings broad, grayish, bases narrowly brightened; stigma and a seam behind vein Cu light brown; numerous macrotrichia on most veins beyond cord; Sc_1 ending about opposite two-thirds length of Rs; male hypopygium with apices of gonapophyses expanded into short, broad, yellow blades.

Male.—Length, about 6 millimeters; wing, 7; antennæ, about 1.2.

Rostrum dark gray; palpi black. Antennæ black, of moderate length, if bent backward ending shortly before wing root; flagellar segments passing through oval to elongate, verticils exceeding segments. Head light gray.

Thorax uniformly dark, gray-pruinose, without evident præscutal stripes; scutellum unbrightened. Halteres pale yellow. Legs with coxæ brown, more or less pruinose, especially fore pair; trochanters testaceous yellow; femora obscure yellow, tips darkened, widest on forelegs where about outer two-thirds is included, narrowest on posterior pair; tibiæ obscure yellow, tips narrowly darkened; tarsi dark brown, basitarsi paler. Wings (Plate 1, fig. 9) broad, grayish, base more brightened; stigma and a seam behind vein Cu light brown; veins pale brown, more yellowish in prearcular and costal portions. Ma-

crotrichia on all longitudinal veins beyond cord with the exception of R_3 and basal portion of R_{2+3+4}. Venation: Sc_1 ending about opposite two-thirds length of Rs, Sc_2 near its tip; R_{2+3+4} slightly shorter than R_4; R_3 short, suberect; veins issuing from cell 1st M_2 not conspicuously arched, m and basal section of M_3 subequal; m-cu at near one-third length of cell 1st M_2.

Abdomen dark brown, including hypopygium. Male hypopygium (Plate 3, fig. 34) with outer dististyle, *od*, relatively stout, apex a decurved acute spine. Inner dististyle, *id*, with apex suddenly narrowed into a cylindrical point. Gonapophyses, *g*, at apex expanded into short, broad, yellow blades.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 2,800 feet, July 5, 1938 (*Yankovsky*). Paratopotype, male, altitude 3,000 feet, July 5, 1938.

Rhabdomastix (*Sacandaga*) *spatulifera* is very different from the other described regional species, especially in the general coloration and in the structure of the male hypopygium, notably of the gonapophyses.

RHABDOMASTIX (SACANDAGA) LURIDOIDES sp. nov. Plate 1, fig. 10; Plate 3, fig. 35.

Belongs to the *lurida* group; general coloration dark, scutellum and lateral borders of præscutum obscure yellow; halteres pale yellow; femora yellow, tips broadly blackened, widest on forelegs; wings brownish yellow, proximal half brighter, including veins; vein Sc_2 lacking; R_3 oblique, with macrotrichia over entire length; male hypopygium with gonapophyses unusually long, strongly curved, narrowed to acute blackened points.

Male.—Length, about 5 to 5.5 millimeters; wing, 5.5 to 6.

Female.—Length, about 6 millimeters; wing, 6.

Rostrum black, sparsely pruinose; palpi black. Antennæ with scape and pedicel black, flagellum brownish black; flagellar segments passing through oval to long-oval, longest verticils unilaterally distributed. Head dark gray.

Anterior lateral pretergites light yellow. Thorax black, sparsely pruinose, lateral margins of præscutum and posterior border of scutellum broadly obscure yellow; in female, præscutal interspaces indicated by narrow reddish lines before suture; in cases sides of mediotergite and pleurotergite obscure yellow, in other specimens these more darkened. Pleura chiefly dark, variegated with obscure yellow; dorsopleural membrane obscure yellow. Halteres pale yellow. Legs with

coxæ obscure yellow; trochanters yellow; femora yellow basally, tips brownish black, widest on forelegs where about outer half is darkened, narrowest on posterior femora where about distal seventh is infuscated; tibiæ brownish yellow, tips narrowly darkened; tarsi brownish yellow, passing into dark brown. Wings (Plate 1, fig. 10) brownish yellow, proximal half somewhat clearer yellow; veins brown in outer portions, yellow in basal areas. Numerous macrotrichia on longitudinal veins beyond cord, including entire length of R_3. Venation: Sc_1 ending nearly opposite fork of Rs, Sc_2 lacking; Rs long, exceeding twice R_{2+3+4}; R_3 very oblique, as in the group; cell 1st M_2 relatively small, shorter than vein M_4 beyond it; m-cu close to midlength of cell 1st M_2.

Abdomen black, sparsely pruinose; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 35) with gonapophyses, *g*, unusually long, strongly curved, narrowed to long, acute, blackened points.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 4,000 feet, July 19, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, several of both sexes, altitude 3,500 to 5,000 feet, July 10 to August 2, 1938 (*Yankovsky*).

Allied to the western Palæarctic *Rhadomastix* (*Sacandaga*) *lurida* (Loew) and *R.* (*S.*) *inclinata* Edwards, differing especially in the structure of the male hypopygium, as the unusually long and slender, curved gonapophyses. Further undescribed member of the group occurs in the Rocky Mountain area of western North America. The strongly oblique R_3, with macrotrichia throughout its length, together with the loss of vein Sc_2, as well as the structure of the male hypopygium, as the acutely pointed gonapophyses, mark the group as very distinct.

CRYPTOLABIS (BÆOURA) SEPTENTRIONALIS sp. nov. Plate 1, fig. 11; Plate 3, fig. 36.

Belongs to the *aliena* group; general coloration gray, præscutum with four slightly more blackish stripes; anterior lateral pretergites restrictedly brightened; halteres infuscated; legs black, only femoral bases restrictedly brightened; wings brownish gray, stigma and vague seams on cord and in axillary region darker; male hypopygium with dististyle moderately slender, penis very long and slender.

Male.—Length, about 4 millimeters; wing, 4.5.

Female.—Length, about 4.5 millimeters; wing, 4.5.

Rostrum black, sparsely pruinose. Antennæ short, black throughout. Head light ashy gray.

Pronotum light gray; anterior lateral pretergites restrictedly obscure yellow. Mesonotal præscutum dark gray; lighter on sides, disc with four slightly more blackish stripes; scutum dark gray; scutellum dark basally, apical border broadly orange; postnotum dark gray. Pleura heavily gray-pruinose; dorsopleural membrane obscure yellow. Halteres infuscated throughout. Legs with coxæ dark gray; trochanters brown; remainder of legs black, femoral bases, especially of posterior legs, obscure yellow. Wings (Plate 1, fig. 11) broad, tinged with brownish gray, prearcular field slightly more yellowish; stigma pale brown, ill-defined but extensive; a vague dark suffusion at cord; axillary region weakly darkened; veins dark brown, brightened in prearcular field, somewhat more intensely darkened along cord. Venation: R_{2+3+4} a little longer than basal section of R_5; m-cu shortly before midlength of M_{3+4}; cell 2d A wide.

Abdomen brownish black, including genitalia of both sexes. Male hypopygium (Plate 3, fig. 36) with ventral lobe of basistyle, *b*, long and conspicuous. Dististyle, *d*, of moderate length and slenderness, sinuous, more dilated on proximal third, central portion with five or six small setiferous tubercles; distal third with numerous, very small, pale punctures; apex obtuse. Ædeagus, *a*, terminating in two small pale blades; penis very long and slender.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,000 feet, July 16, 1938 (*Yankovsky*). Allotopotype, female, altitude 4,500 feet, July 16, 1938.

Cryptolabis (*Bæoura*) *septentrionalis* is very distinct from the other known regional species of the subgenus. In the very elongate ædeagus and penis it resembles *C.* (*B.*) *dicladura* Alexander and *C.* (*B.*) *perductilis* Alexander, of southern and western China, differing very conspicuously in the structure of the dististyle. This is the most northerly representative of *Bæoura* so far discovered.

ORMOSIA (ORMOSIA) DEVOTA sp. nov. Plate 1, fig. 12; Plate 3, fig. 37.

General coloration gray; antennal flagellum pale brown; halteres obscure yellow; legs brown; wings grayish, stigma a little darker than ground; macrotrichia of cells long and dense; cell 1st M_2 small, closed; m-cu at fork of M; vein 2d A moderately sinuous; male hypopygium with two simple disti-

styles, outer broader, slightly enlarged, and set with dense rows of scales; inner dististyles slender, at apex slightly enlarged and bearing two powerful setæ.

Male.—Length, about 6 millimeters; wing, 6.5; antennæ, about, 1.4.

Rostrum and palpi black. Antennæ moderately long; basal two segments somewhat darker brown than flagellum; outer flagellar segments elongate-cylindrical, with verticils considerably longer than segments and unilaterally distributed. Head gray, with abundant pale pubescence.

Mesonotum gray, central portion of præscutum more brownish gray but without distinct stripes; pubescence of thorax long and pale. Pleura dark gray; a conspicuous group of long yellow setæ on pleurotergite. Halteres obscure yellow. Legs with coxæ dark gray; trochanters brown; remainder of legs brown. Wings (Plate 1, fig. 12) grayish, prearcular field restrictedly yellow; stigma a little darker than ground; cord vaguely seamed with darker; veins brown, trichia a little darker, long, and dense (indicated in figure by stippling). Venation: Sc_2 about opposite midlength of comparatively short straight Rs; R_2 close to fork of R_{2+3+4}; cell 1st M_2 small, closed, shorter than any of veins issuing from it; m-cu at fork of M; vein 2d A moderately sinuous.

Abdomen dark brown, hypopygium a little brightened. Male hypopygium (Plate 3, fig. 37) with two simple dististyles, outer, *od,* broader, slightly enlarged outwardly, apex with dense rows of flattened scales. Inner dististyle, *id,* subequal in length but slender, at apex with a spinous point on one side; two terminal setæ, one shorter and slenderer, the second long and strong, directed more or less backward. Phallosome, *p,* difficult to describe from the unique slide mount, appearing as two flattened apophyses on either side of an urn-shaped spinulose median structure.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 4,000 feet, July 10, 1938 (*Yankovsky*).

Ormosia (*Ormosia*) *devota* is entirely different from all known species of the genus. From other gray species having cell 1st M_2 closed it differs in the structure of the male hypopygium which somewhat suggests that of species of the *vivittata* group yet is quite distinct. The clavate squamose head of the outer dististyle is much as in species of the otherwise

distinct *similis* group in *Ormosia* and in certain other eriopterine groups.

ORMOSIA (ORMOSIA) CATA sp. nov. Plate 1, fig. 13; Plate 3, fig. 38.

General coloration polished black; antennæ black throughout; head gray; anterior lateral pretergites light yellow; thoracic pleura gray-pruinose; femora yellow, tips abruptly blackened, broadest on forelegs; wings with a faint dusky tinge, prearcular and costal portions clear light yellow, stigma brown; R_2 close to base of cell R_3; cell 1st M_2 closed, with m-cu close to its inner end; anal veins divergent; male hypopygium with inner dististyle a simple blackened rod; ædeagus slender, terminating in a small sagittate head.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black throughout, moderately elongate, if bent backward extending approximately to wing root; flagellar segments oval, with a dense white pubescence. Head gray.

Pronotum black, sparsely pruinose; anterior lateral pretergites abruptly light yellow. Mesonotum almost uniformly polished black, præscutum very weakly pruinose on lateral portions; posterior lateral portions of scutal lobes obscure yellow. Pleura black, heavily dusted with gray; dorsopleural membrane dusky. Halteres with stem obscure yellow, knob clear yellow. Legs with coxæ brownish yellow, fore pair somewhat darker; trochanters yellow; femora yellow, tips conspicuously blackened, most extensively so on forelegs where about the distal half is darkened, narrower on other legs, including about outer fifth or sixth; tibiæ obscure yellow, tips darkened; tarsi dark brown. Wings (Plate 1, fig. 13) with a faint dusky tinge, prearcular and costal regions clear light yellow; stigma oval, dark brown; a scarcely evident darkening along vein Cu in cell M; veins dark brown, yellow in flavous portions. Macrotrichia covering almost whole wing surface (indicated in figure by stippling). Venation: R_2 close to fork of R_{2+3+4} and base of cell R_3; cell 1st M_2 closed, m-cu close to its inner end; anal veins divergent, 2d A gently sinuous.

Abdomen, black, hypopygium somewhat brightened. Male hypopygium (Plate 3, fig. 38) with the tergal lobes, *9t*, small, gently divergent, separated by a U-shaped notch. Basistyle, *b*, with conspicuous dorsal and ventral lobes. Outer dististyle, *od*, large, club-shaped, bearing a sclerotized fingerlike rod on mar-

gin. Inner dististyle a slender, simple, blackened rod. What seem to represent gonapophyses, *g*, appear as flattened blades, the outer angle of each produced into an acute spine. Ædeagus, *a*, slender, terminating in a small sagittate head, apex obtuse.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 2,800 feet, July 5, 1938 (*Yankovsky*).

Ormosa (*Ormosa*) *cata* is very distinct from all described regional species, being most similar to *O.* (*O.*) *prava* sp. nov., described below. It is well distinguished by the color of the wings and legs, venation, and the structure of the male hypopygium.

ORMOSIA (ORMOSIA) PRAVA sp. nov. Plate 1, fig. 14; Plate 3, fig. 39.

General coloration polished black; halteres with bright yellow knobs; femora black, bases obscure yellow, involving basal third or a little more; wings brownish yellow, costal region clearer yellow; a conspicuous brown pattern including stigma and broad seams at cord and along vein Cu; R_{2+3+4} short, R_{2+3} preserved; cell 1st M_2 closed; m-cu beyond fork of M; anal veins divergent; male hypopygium with inner dististyle a broad blackened plate that is produced laterad into a strong black spine.

Male.—Length, about 6 millimeters; wing, 7; antennæ, about 2.

Female.—Length, about 7 to 7.5 millimeters; wing, 6.5 to 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval. Head dark gray.

Pronotum black; anterior lateral pretergites obscure brownish yellow. Mesonotum polished black, surface not or scarcely pruinose. Pleura black, sparsely dusted with gray; dorsopleural membrane brownish black. Halteres with stem dusky, knob bright yellow. Legs with coxæ black; trochanters reddish brown; femora black, bases obscure yellow, involving proximal third or a little more; tibiæ brownish black to black, both ends somewhat darker; tarsi black. Wings (Plate 1, fig. 14) with ground color brownish yellow, prearcular field and costal region clearer yellow; stigma and broad conspicuous seams at origin of Rs, cord and outer end of cell 1st M_2, and along vein Cu, dark brown; anal cells washed with somewhat paler brown, especially on basal portions; some of longitudinal veins beyond cord very narrowly seamed with brown; veins coarse, dark brown, more yellowish in brightened costal portions. Macrotrichia of cells abundant, lacking only at wing base (indicated

in figure by stippling). Venation: R_{2+3+4} short to very short, subequal to R_{2+3}, R_2 thus beyond fork of R_{2+3+4}; cell 1st M_2 closed, varying from short to longer rectangular; m-cu shortly beyond fork of M; anal veins divergent. In one paratype, on both wings, outer third of distal section of vein M_{1+2} atrophied.

Abdomen black, subnitidous, including hypopygium and genital shield of female; cerci of latter pale yellow to light horn-colored. Male hypopygium (Plate 3, fig. 39) with what appears to be the tergite, *9t*, narrowly transverse, produced caudad into a broad pale membrane, more sclerotized basal portions with punctures, remainder with only microscopic pubescence. Basistyle, *b*, with mesal lobe longer and more pointed than outer lobe. Outer dististyle, *od*, a massive clavate structure whose true extent and conformation is difficult to decide in the type and which is evidently more complex than illustrated, the head with abundant long coarse setæ. Inner dististyle, *id*, a broad blackened plate, its apex produced laterad into a long, strong, black spine. Ædeagus, *a*, terminating in two rods that are recurved at tips into short spines. The conspicuous plate-like apophyses of the related *O. cata* seem to have no homologues in this species.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,000 feet, July 5, 1938 (*Yankovsky*). Allotopotype, female, altitude 2,500 feet, June 17, 1938. Paratopotypes, 6 females, altitude 3,000 to 3,200 feet, June 15 to 30, 1938.

The nearest relative is *Ormosia* (*Ormosia*) *cata* sp. nov., which has the general coloration similarly polished black. The present fly differs in the larger size, heavily patterned wings, distinct leg pattern, and especially in the very different male hypopygium.

ORMOSIA (ORMOSIA) DUCALIS Alexander.

Ormosia (*Ormosia*) *ducalis* ALEXANDER, Philip. Journ. Sci. 67 (1938) 162, 163.

This very distinct fly has been known from the unique type. Numerous specimens, Ompo, Northern Korea, altitude 200 to 700 feet, May 18 to 28, 1938; Seren Mountains, altitude 2,500 to 4,200 feet, June 18 to July 3, 1938 (*Yankovsky*).

ORMOSIA (ORMOSIA) YANKOVSKYI sp. nov. Plate 1, fig. 15; Plate 3, fig. 40.

General coloration pale yellow; antennæ brown; femora and tibiæ yellow, tips narrowly but conspicuously blackened, tarsi uniformly black; wings yellow, veins pale and indistinct; cells

M_2 open by atrophy of m; male hypopygium with phallosome heavily blackened, asymmetrical.

Male.—Length, about 4 to 4.2 millimeters; wing, 4 to 4.5.

Female.—Length, about 4.5 millimeters; wing, 4.5 to 4.8.

Rostrum brownish testaceous; palpi dark brown. Antennæ brown; flagellar segments oval. Head brown.

Thorax uniformly pale yellow, without clearly defined markings. Halteres pale yellow. Legs with coxæ and trochanters yellow; femora yellow, tips narrowly but abruptly brownish black, the amount subequal on all legs; tibiæ yellow, tips conspicuously blackened, the amount about twice as extensive as femoral darkening; tarsi black. Wings (Plate 1, fig. 15) with a uniform pale yellow tinge, veins a little deeper colored but inconspicuous against ground. Macrotrichia well distributed (indicated in figure by stippling). Venation: Sc short, Sc_1 ending about opposite fork of Rs; cell R_3 deep; cell M_2 open by atrophy of m; m-cu close to fork of M; vein 2d A short and nearly straight.

Abdomen, including hypopygium, yellow, tergites a trifle darker. Male hypopygium (Plate 3, fig. 40) with both dististyles simple, pale; outer style slender, surface with microscopic appressed spines. Inner dististyle, *id,* a trifle longer, tip obtuse with a few setæ at apex. Phallosome, *p,* heavily blackened, asymmetrical, including a cylindrical lateral rod with apex obtuse.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 200 feet, May 18, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, numerous specimens of both sexes, altitude 100 to 800 feet, May 18 to 29, 1938; paratypes, Seren Mountains, altitude 3,000 to 4,500 feet, June 21 to July 18, 1938 (*Yankovsky*).

Allied to *Ormosia* (*Ormosia*) *confluenta* Alexander, of Japan, differing conspicuously in the pattern of the legs and in the structure of the male hypopygium, as the heavily blackened phallosome. I take very great pleasure in dedicating this fly to the collector, Mr. Alexander Yankovsky.

ORMOSIA (ORMOSIA) CORNUTOIDES sp. nov. Plate 1, fig. 16; Plate 3, fig. 41.

General coloration dark gray; antennæ dark throughout; halteres pale yellow; femora obscure yellow, passing into dark brown; wings pale yellow, stigma brown, conspicuous; vein R_2 close to fork of R_{2+3+4}; cell M_2 open by atrophy of basal section

of M_3; vein 2d A moderately sinuous; male hypopygium with inner margin of outer dististyle produced into a strong spine; inner dististyle conspicuously spinous; gonapophyses appearing as slender yellow rods that are connected with broadly flattened plates subtending ædeagus.

Male.—Length, about 4 to 4.5 millimeters; wing, 4.5 to 5.5; antennæ, about 1 to 1.2.

Female.—Length, about 4.5 to 5 millimeters; wing, 5 to 5.5.

Rostrum and palpi black. Antennæ of moderate length; scape and pedicel black, flagellum dark brown; flagellar segments oval. Head dark gray.

Mesonotum dark gray, unmarked; setæ of præscutal interspaces pale. Pleura dark gray. Halteres pale yellow throughout. Legs with the coxæ and trochanters testaceous yellow; femora obscure yellow basally, passing into dark brown; tibiæ brownish yellow, both ends narrowly darkened; tarsi brownish black. Wings (Plate 1, fig. 16) with a pale-yellow tinge, clearest on prearcular and costal fields; stigma brown, conspicuous; veins brown, yellow in pale areas. Venation: R_2 at or just beyond fork of R_{2+3+4}; cell M_2 open by atrophy of basal section of vein M_3; vein 2d A moderately sinuous.

Abdomen dark brown; hypopygium a trifle brightened. Male hypopygium (Plate 3, fig. 41) with tergite, *9t*, a flattened-depressed plate, apical margin gently concave to nearly truncate, surface with microscopic setulæ. Outer dististyle, *od*, blackened, relatively narrow, inner margin produced into a strong black spine; apex produced into a membranous lobe. Inner dististyle, *id*, complex, consisting of an outer flattened black plate that is extended into two, or occasionally, three spinous points; at base of plate a further group of three black spines. Phallosome, *p*, consisting of slender, gently curved, yellow apophyses, acute tips blackened and acute; ædeagus subtended by conspicuous flattened plates.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 1,000 feet, May 23, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, 3 females, 1 male, altitude 400 feet, May 19, 1938. Paratype, male, Seren Mountains, altitude 6,000 feet, June 25, 1938 (*Yankovsky*).

Ormosia (*Ormosia*) *cornutoides* is quite distinct from all other species described from eastern Asia. It is more similar to the western Nearctic *O.* (*O.*) *cornuta* (Doane) and *O.* (*O.*) *subcornuta* Alexander, yet amply distinct in the structure of the male hypopygium.

ORMOSIA (ORMOSIA) FRAGMENTATA sp. nov. Plate 1, fig. 17; Plate 3, fig. 42.

General coloration dark plumbeous gray, thorax unmarked; halteres pale yollow; legs obscure yellow; wings with a weak brown tinge, large stigma darker brown; R_{2+3} and R_2 subequal, cell R_3 deep; cell M_2 open by atrophy of basal section of M_3; male hypopygium with outer dististyle expanded into a triangular blade, truncate outer margin cut into three or four lobes by notches; gonapophyses appearing as slender black rods on either side of an entire depressed median plate.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.5 to 4.7; antennæ, about 1.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum brownish gray; palpi black. Antennæ of moderate length, dark brown; flagellar segments subcylindrical, verticils longer than segments. Head dark gray.

Mesonotum and pleura dark plumbeous gray, without markings. Halteres pale yellow. Legs with coxæ dark brown; trochanters obscure yellow; remainder of legs obscure yellow, terminal tarsal segments darkened. Wings (Plate 1, fig. 17) with a weak brownish tinge, prearcular and costal fields light yellow; stigma large, brown; vague pale-brown washes at cord and along vein Cu; veins brown, brighter in yellow areas. Macrotrichia of cells abundant but arising from small pale punctures (indicated in figure by stippling). Venation: R_{2+3} and R_2 subequal, both about two-thirds R_{2+3+4}; cell R_3 deep; cell M_1 deep; cell M_2 open by atrophy of basal section of M_3; m-cu erect, at fork of M; vein 2d A gently sinuous on distal third.

Abdomen dark brown, hypopygium scarcely brightened. Male hypopygium (Plate 3, fig. 42) with the two dististyles nearly terminal. Outer dististyle, *od,* blackened, expanded into a triangular blade, truncated outer margin cut into three or four lobes with fimbriate margins; surface of style with abundant small black setæ. Inner dististyle, *id,* a little larger, outer margin roughened by scabrous points, apex an irregular blade that is fimbriate by irregular teeth. Phallosome, *p,* appearing as simple black apophyses arising laterally from a broadly depressed, yellow, median plate, caudal margin of the latter entire. Ædeagus very slender, narrowed to an acute point.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 150 feet, May 8, 1938 (*Yankovsky*). Allotopotype, female, altitude 400 feet, May 19, 1938.

Paratopotypes, males and females, altitude 150 to 250 feet, May 7 to 13, 1938; altitude 400 feet, May 19, 1938 (*Yankovsky*).

Ormosia (*Ormosia*) *fragmentata* is entirely different from all known regional species of approximately similar general appearance. The structure of the male hypopygium is quite distinctive.

ERIOPTERA (ERIOPTERA) BICORNIFER Alexander.

Erioptera (*Erioptera*) *bicornifer* ALEXANDER, Ann. Ent. Soc. America 14 (1921) 116.

Described from the main island of Japan. Northern Korea, Seren Mountains, altitude 1,500 to 2,000 feet, July 16 to August 27, 1938 (*Yankovsky*).

ERIOPTERA (ERIOPTERA) FUSCOHALTERATA Alexander.

Erioptera (*Erioptera*) *fuscohalterata* ALEXANDER, Proc. U. S. Nat. Mus. Art. 4 68 (1925) 11, 12.

Known hitherto from various stations in eastern Siberia.

Northern Korea, Chonsani, Paiktusan, altitude 3,600 feet, July 13, 1937 (*Yankovsky*). Seren Mountains, altitude 2,800 to 3,000 feet, June 22 to 30, 1938 (*Yankovsky*). The male hypopygium of the unique type was defective in the loss of the outer dististyle and may be redescribed as follows: Outer dististyle appearing as a flattened dark-colored blade that narrows to the obtusely rounded apex. Inner dististyle with apical spine provided with numerous setigerous punctures; on outer margin of style, opposite recurved tip of apical spine, with one or two small spines or strong setigerous tubercles. On what appears to be the ninth tergite, on either side, a microscopic sensory peg.

ERIOPTERA (ERIOPTERA) MEDIOFUSCA sp. nov. Plate 1, fig. 18; Plate 4, fig. 43.

General coloration brown, præscutum darker medially; pleura dark brown, variegated with obscure yellow; knobs of halteres dark brown; femora brown, bases restrictedly yellow; wings subhyaline, with a weak brown tinge, veins pale brown; male hypopygium with outer dististyle a slender blackened rod, tip acute; inner dististyle with tip recurved, blackened; gonapophyses appearing as simple blackened spines.

Male.—Length, about 5 to 6 millimeters; wing, 5 to 7.

Rostrum and palpi black. Antennæ with basal segments brown, outer segments somewhat paler; flagellar segments elongate, subcylindrical; terminal segments shorter than penultimate. Head brownish gray.

Pronotum dark brown medially, yellow on sides; anterior lateral pretergites yellow. Mesonotal præscutum grayish brown, darker brown medially in front, area delimited by row of setigerous punctures on interspaces; scutal lobes darkened; scutellum dark brown; postnotum reddish brown. Pleura chiefly dark brown, variegated with obscure yellow, especially on ventral sternopleurite and dorsopleural membrane. Halteres with stem yellow, outer end and knob dark brown. Legs with coxæ obscure brownish yellow; trochanters yellow; femora brown to dark brown, bases restrictedly yellow; tibiæ and tarsi brownish yellow, terminal tarsal segments dark brown. Wings (Plate 1, fig. 18) subhyaline, with a weak brown tinge; stigmal region vaguely infuscated; veins yellowish brown to pale brown; macrotrichia dark. Venation: vein 2d A strongly sinuous.

Abdomen dark brown, sparsely pruinose; hypopygium reddish yellow. Male hypopygium (Plate 4, fig. 43) with the tergite, *9t*, lacking a specially modified sensory peg. Outer dististyle, *od*, slender, simple, blackened, tip acute. Inner dististyle, *id*, with tip strongly recurved, blackened; outer margin at near midlength with a small, more or less developed, chitinized point, in cases a small spine. Gonapophyses, *g*, appearing as simple blackened spines.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude, 2,500 feet, June 18, 1938 (*Yankovsky*). Paratopotypes, 10 males, altitude 2,500 to 6,000 feet, June 14 to 25, 1938 (*Yankovsky*).

Erioptera (*Erioptera*) *mediofusca* has the hypopygium very similar to that of *E.* (*E.*) *fuscohalterata* Alexander, but the coloration of the body, legs, and wings is quite different. *E.* (*E.*) *lutea* Meigen, of Europe, likewise has a hypopygium of somewhat similar structure, especially the inner dististyle, but the outer dististyle is much broader and of different conformation.

ERIOPTERA (ERIOPTERA) HORII Alexander.

Erioptera (*Erioptera*) *horii* ALEXANDER, Philip. Journ. Sci. 24 (1924) 583, 584.

Widely distributed in northern Japan. Northern Korea, Ompo, altitude 150 feet, June 7, 1937 (*Yankovsky*).

ERIOPTERA (ERIOPTERA) SEX-ACULEATA sp. nov. Plate 1, fig. 19; Plate 4, fig. 44.

General coloration, including antennæ, halteres, and legs, pale yellow; wings yellow, veins poorly differentiated against

ground; male hypopygium with both diststyles simple, outer extended into a long straight black spine; gonapophyses of either side bearing three blackened spinous points, most lateral point larger and microscopically roughened.

Male.—Length, about 5 millimeters; wing, 5.8.

Rostrum yellow; palpi pale brown. Antennæ pale brownish yellow, outer segments even paler; flagellar segments with unusually long pale verticils. Head yellow.

Thorax uniformly pale yellow, unmarked. Halteres yellow throughout. Legs yellow, outer tarsal segments a trifle darker. Wings (Plate 1, fig. 19) pale yellow, veins and macrotrichia a trifle darker than ground. Venation: 2d A unusually sinuous.

Abdomen, including hypopygium, yellow. Male hypopygium (Plate 4, fig. 44) with both diststyles simple, long and slender, outer, *od,* slightly more expanded on basal two-thirds, apex a straight black spine; inner style, *id,* a little shorter, tip narrowly blackened. Gonapophyses, *g,* on either side bearing three spines, most lateral spines larger, blackened apex microscopically roughened; inner spines slenderer, tips conspicuously blackened.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,500 feet, June 30, 1938 (*Yankovsky*).

Erioptera (*Erioptera*) *sex-aculeata* is quite distinct from the other regional species, especially from all those having the halteres and legs uniformly yellow. The structure of the gonapophyses is quite distinctive of the species.

ERIOPTERA (ILISIA) ASYMMETRICA Alexander.

Erioptera (*Acyphona*) *asymmetrica* ALEXANDER, Canad. Ent. 45 (1913) 289, 290.

Northern Korea, Seren Mountains, altitude 2,000 to 4,500 feet, August 21 to September 15, 1938 (*Yankovsky*).

ERIOPTERA (ILISIA) SERENICOLA sp. nov. Plate 1, fig. 20; Plate 4, fig. 45.

General coloration dark gray; halteres pale yellow; femora brownish yellow basally, tips broadly brownish black; tibiæ obscure brownish yellow, both ends more darkened; wings pale yellow, heavily patterned with dark brown; cell 1st M_2 elongate, closed; male hypopygium with outer diststyle deeply divided into two shell-like blades; inner diststyle entirely pale; each gonapophysis blackened, profoundly but unequally bifid.

Male.—Length, about 5 to 5.5 millimeters; wing, 6.5 to 7.

Female.—Length, about 6 to 6.5 millimeters; wing, 7.5 to 8.

Rostrum dark gray; palpi black. Antennæ (male) moderately long, if bent backward extending about to wing root; basal segments pale brownish yellow, outer five or six flagellar segments darker; flagellar segments long-oval. Head dark gray.

Pronotum dark, anterior lateral pretergites obscure yellow. Mesonotal præscutum dark gray, center of præscutum a little darker; pseudosutural foveæ black. Pleura dark gray; dorsopleural membrane dark brown. Halteres pale yellow. Legs with coxæ gray; trochanters brown; femora brownish yellow basally, tips broadly brownish black, including distal third or more of segment; tibiæ obscure brownish yellow, bases narrowly, tips more broadly blackened; tarsi dark brown to brownish black. Wings (Plate 1, fig. 20) with ground color pale yellow and a relatively heavy dark-brown pattern, including three major costal areas at origin of Rs, stigma and tip of R_{1+2}; cord and outer end of cell 1st M_2 seamed with brown; a marginal series of spots at ends of all longitudinal veins, largest at R_3 and 2d A; small dark clouds at h, arculus, and fork of M_{3+4}; a more or less extensive dark seam near midlength of basal section of Cu_1, in cases including about one-third length of section, in others reduced to small spot; axillary margin in cell 2d A narrowly bordered by dusky; veins yellow, dark brown in clouded areas. Venation: Rs relatively short, only a little longer than R; Sc_2 only a short distance beyond origin of Rs; cell 1st M_2 elongate, closed, much exceeding vein M_{1+2} beyond it; vein 2d A straight.

Abdomen, including hypopygium, black. Male hypopygium (Plate 4, fig. 45) with outer dististyle, *od*, deeply divided into two flattened shell-like blades, outer blade a little larger, yellow, with outer margin blackened, inner blade dusky, more obtuse at apex; a further blackened spinous point midlength of style. Inner dististyle, *id*, entirely pale, expanded at base, constricted at midlength, apex a little expanded. Gonapophyses, *g*, profoundly bifid, heavily blackened, outer arm a nearly straight rod, apical third gently incurved, outer margin microscopically serrulate; inner arm about one-half as long and slenderer, very gently curved, tip with a few denticles.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,200 feet, June 21, 1938 (*Yankovsky*). Allotopotype, female, pinned with

type. Paratopotypes, several of both sexes, altitude 2,000 to 3,800 feet, June 15 to July 10, 1938 (*Yankovsky*).

Erioptera (*Ilisia*) *serenicola* is very different from all other described species of the genus. In its wing pattern it more resembles species of the subgenus *Hoplolabis* Osten Sacken, but from the venation must be referred to *Ilisia.*

ERIOPTERA (SYMPLECTA) HYBRIDA (Meigen).

Limonia hybrida MEIGEN, Klass. 1 (1804) 57.

Widespread over the entire northern Palæarctic region but not in the Nearctic, as formerly supposed, being there replaced by *E.* (*S.*) *cana* (Walker) which ranges as far south as Guatemala and southern Mexico. The following records for *hybrida* greatly extend its recorded range eastward in Asia.

Western China, Kwanhsien, Szechwan, altitude 4,500 feet, August 4, 1930 (*G. M. Franck*). Northern Japan, Abashiri, Hokkaido, August 31, 1922 (*Teiso Esaki*). Northern Korea, Seren Mountains, altitude 3,500 feet, September 14, 1938 (*Yankovsky*). One male specimen from Korea, on one wing only, has a spur of a vein from 2d A to the margin, thus producing the venation of the subgenus *Podoneura* Bergroth.

I am following Edwards[3] in using the name *Symplecta* and in relegating it to subgeneric rank under the older genus *Erioptera.* For many years the subgenus had been called *Helobia* St. Fargeau, but *Symplecta* has now been found to be the prior name.[4]

ERIOPTERA (SYMPLECTA) CHOSENENSIS sp. nov. Plate 1, fig. 21; Plate 4, fig. 46.

General coloration gray; antennæ black throughout; mesonotal præscutum with three narrow dark-brown stripes; scutellum gray, with a narrow brown median vitta; postnotum light gray; pleura brownish gray, variegated with yellow on pteropleurite and caudal portion of sternopleurite; knobs of halteres brownish black; legs black, femoral bases brown; wings pale yellowish subhyaline, spotted with brown; Sc_2 at or beyond one-third length of Rs; m about one-half basal section of M_3;

[3] Trans. Soc. British Ent. pt. 1 5 (1938) 126.

[4] *Helobia* St. Fargeau, Encycl. Method. Ins. 10 (1828) 585; in the past the date has commonly been given as 1825, in which case it antedated *Helobia* Stephens, Ill. Brit. Ent. Mandibulata (1827) 45, 60, 61, credited by Stephens to Leach. According to Sherborn and others, the actual date of *Helobia* St. Fargeau is 1828, and the name *Symplecta* Meigen must be used, as is done above.

male hypopygium with outer dististyle deeply bifid, arms smooth and blackened; inner dististyle at apex expanded into a small head; gonapophyses smooth, blackened, conspicuously and unequally bispinous at tips.

Male.—Length, about 4.5 to 5 millimeters; wing, 4.5 to 5.

Rostrum and palpi black. Antennæ black throughout, relatively long (male), if bent backward extending nearly to wing root; flagellar segments oval to long-oval. Head light gray; eyes (male) large, anterior vertex narrow.

Pronotum obscure yellow, narrowly dark brown medially. Mesonotal præscutum light brown, humeral and lateral portions yellow; three narrow dark-brown stripes, median stripe nearly complete, lateral pair short, beginning behind transverse black pseudosutural foveæ; scutum brownish gray, each lobe with a dark-brown dash; scutellum light gray, with a narrow brown median vitta; postnotum light gray. Pleura chiefly dark brownish gray, variegated with yellow, including most of pteropleurite and a confluent spot at caudal portion of sternopleurite; dorsopleural membrane dusky. Halteres with stem yellow, knob brownish black. Legs with coxæ brownish yellow; trochanters obscure yellow; femora brown, tips passing into black; tibiæ and tarsi black. Wings (Plate 1, fig. 21) pale yellowish subhyaline; prearcular and costal areas somewhat clearer yellow; a restricted brown pattern, including areas at origin of Rs, Sc_2, cord, outer end of cell 1st M_2, tip of R_{1+2}, and at supernumerary crossvein in cell R_3; smaller and somewhat paler brown areas at end of vein R_3, at midlength and near tip of 2d A, at margin of midlength of cell 2d A, and postarcular in base of cell M; veins pale brown, darker in clouded areas. Venation: Sc_2 some distance beyond origin of Rs, at or beyond one-third length of vein; supernumerary crossvein in cell R_3 opposite tip of vein R_{1+2}; m about one-half basal section of M_3; m-cu oblique, about two-thirds its length before fork of M; vein 2d A moderately sinuous.

Abdominal tergites dark brown, sternites somewhat more pruinose, lateral borders restrictedly yellow; hypopygium more yellowish. Male hypopygium (Plate 4, fig. 46) without terminal lobes on basistyle, *b*. Outer dististyle, *od*, deeply bifid, arms smooth and blackened; outer arm a little stouter than inner, especially on basal portion. Inner dististyle, *id*, weakly darkened, at apex expanded into a small head. Gonapophyses, *g*, smooth, blackened, conspicuously bispinous at tips, outer spine much longer than inner or lower one.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,000 feet, July 16, 1938 (*Yankovsky*). Paratopotypes, males and females, altitude 5,000 feet, September 14, 1938 (*Yankovsky*).

Erioptera (*Symplecta*) *chosenensis* is very different from all known species of the subgenus, especially in the structure of the male hypopygium. Insofar as can be judged from a comparison of different sexes only it is apparently closest to *E.* (*S.*) *scotica* Edwards, still known only from females taken in Scotland. This latter fly differs in various details of coloration and venation, especially the pattern of the scutellum, and in the distal position of Sc_2, with the dark areas at origin of Rs and on Sc_2 entirely separate.

ERIOPTERA (EMPEDA) SUBNUBILA sp. nov. Plate 1, fig. 22; Plate 4, fig. 47.

General coloration clear light gray; palpi and antennæ black; halteres pale yellow; legs brown, without scales; wings whitish subhyaline, stigma very slightly darker; veins pale; male hypopygium with outer dististyle bifid, stem fully as long as outer branch; both branches sclerotized and somewhat blackened, outer branch bispinous at tip; inner dististyle with apex less pointed than in *cinerascens.*

Male.—Length, about 4 millimeters; wing, 4.5.

Rostrum dark gray; palpi black. Antennæ black. Head light gray.

Pronotum gray; lateral pretergites light yellow. Mesonotum clear light gray, præscutal interpaces differentiated by a slightly more brownish line and by a series of long erect setæ; pseudosutural foveæ linear, black. Pleura gray, including dorsopleural membrane. Halteres pale yellow, knob large. Legs with coxæ testaceous brown, sparsely pruinose; trochanters yellow; remainder of legs brown, terminal tarsal segments more brownish black; legs without scales. Wings (Plate 1, fig. 22) whitish subhyaline, stigma very slightly darker; prearcular and costal regions somewhat more whitened; veins pale brown. Venation: Vein R_3 slightly more arcuated and less oblique than in *cinerascens;* cell M_3 shallower.

Abdomen dark brown, sparsely pruinose; hypopygium a little brightened. Male hypopygium (Plate 4, fig. 47) with the outer dististyle, *od,* bifid, fused basal portion or stem fully as long as outer branch; both branches sclerotized and somewhat blackened; outer branch dilated on basal two-thirds, tip bispinous, before apex with a lateral rounded shoulder. In *cinerascens* all

dististyles are pale, outer branch very short, trispinous at apex. Inner dististyle, *id*, narrower than in *cinerascens*, apex less pointed.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,000 feet, June 17, 1938 (*Yankovsky*).

Erioptera (*Empeda*) *subnubila* is closest to the European *E.* (*E.*) *cinerascens* Meigen (*nubila* Schummel). It is most readily told by the structure of the male hypopygium. Edwards [5] considers *Empeda* Osten Sacken and *Gonempeda* Alexander as representing subgenera of the genus *Cheilotrichia* Rossi. I still believe all three represent subgeneric groups in the major genus *Erioptera* Meigen.

MOLOPHILUS (MOLOPHILUS) TRIACANTHUS Alexander.

Molophilus triacanthus ALEXANDER, Philip. Journ. Sci. 53 (1934) 294, 295.

Formerly known only from the mountains of Honshiu, Japan.

Northern Korea, Ompo, altitude 200 to 800 feet, May 8 to 29, 1938 (*Yankovsky*).

MOLOPHILUS (MOLOPHILUS) MONACANTHUS sp. nov. Plate 1, fig. 23; Plate 4, fig. 48.

Belongs to the *gracilis* group and subgroup; general coloration black; femora black with about basal third yellow; tibiæ obscure yellow, bases and tips darkened; wings with a strong brownish tinge, prearcular and costal portions clearer yellow; male hypopygium with ventromesal lobe of basistyle extensive, produced into a group of short spinous points; outer dististyle a little expanded at apex; phallosomic structure at apex produced into a long straight spine.

Male.—Length, about 4.5 millimeters; wing, 4.8 to 5; antennæ, about 1.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ short, dark brown throughout; flagellar segments oval, longest verticils unilaterally arranged and much exceeding segments. Head gray.

Pronotum black, pretergites restrictedly but conspicuously pale yellow. Mesonotum black, very sparsely pruinose to produce a slightly opaque appearance. Pleura dull black, dorsopleural membrane dark brown. Halteres pale yellow, only base of stem weakly infumed. Legs with coxæ and trochanters

[5] Trans. Soc. British Ent. pt. 1 5 (1938) 119.

black; femora black, bases yellow, including about proximal third; tibiæ obscure yellow, extreme base and wider tip infuscated; tarsi dark brown. Wings (Plate 1, fig. 23) with a strong brown tinge, prearcular and costal fields light yellow; veins and trichia darker brown. Venation: R_2 lying shortly distad of r-m; petiole of cell M_3 approximately three times m-cu; vein 2d A long, ending a short distance beyond m-cu.

Abdomen, including hypopygium, black. Male hypopygium (Plate 4, fig. 48) with dorsal lobe of basistyle short, terminating in a small acute point; ventromesal lobe, *vb*, much broader, inner mesal portion produced into a number of spinous points, including a larger triangular black tooth slightly more basad in position. Outer dististyle, *od*, a nearly straight rod, at apex a little expanded and produced laterad into a point. Inner dististyle, *id*, little shorter, appearing as a slender, nearly straight spine from a slightly expanded base, surface with numerous setæ. Phallosome, *p*, an oval plate, apex produced into a single long, straight, black spine; surface of expanded basal portion with abundant close-set setigerous tubercles to produce a somewhat squamose appearance. Ædeagus, *a*, pale yellow, provided with expanded flanges.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 2,800 feet, July 5, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, males and females, altitude 1,800 to 3,800 feet, June 10 to July 10, 1938; paratypes, males and females, Ompo, altitude 700 to 1,000 feet, May 23, 1938 (*Yankovsky*).

Molophilus (*Molophilus*) *monacanthus* is quite distinct from all other regional black species, differing especially in the structure of the male hypopygium, notably the unispinous phallosomic structure. In its general appearance it is amazingly like the species next considered, *M.* (*M.*) *facinus* sp. nov., but the structure of the hypopygium is entirely distinct.

MOLOPHILUS (MOLOPHILUS) FACINUS sp. nov. Plate 4, fig. 49.

Belongs to the *gracilis* group and subgroup; general coloration black, including head, thorax, and abdomen; halteres yellow; femora yellow basally, tips broadly brownish black, widest on fore femora; tibiæ yellow, with both ends narrowly darkened; wings brownish gray, prearcular and costal portions pale yellow; Rs very long; male hypopygium with basistyle terminating in three lobes, mesal lobe longest; two

simple dististyles, outer one nearly straight, its distal half with microscopic spinulæ; inner dististyle a sinuous blackened horn that is extended into a long slender point; phallosomic plate depressed-flattened, apex obtuse, surface with scattered microscopic setulæ.

Male.—Length, about 4 millimeters; wing, 4.5; antennæ, about 1.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ with scape and pedicel black, flagellum paler, brownish yellow to brown, outer segments darker; flagellar segments oval, with long verticils. Head black.

Thorax black, surface of præscutum subnitidous. Halteres very pale yellow. Legs with coxæ brownish black to black; trochanters obscure yellow; femora yellow basally, tips broadly brownish black, including about distal half of fore femora and approximately three-fourths of posterior pair; tibiæ light yellow, with each end narrowly darkened; basitarsi brownish yellow, remainder of tarsi black. Wings brownish gray, prearcular and costal portions restrictedly pale yellow; veins pale brown, macrotrichia darker. A few scattered setigerous punctures at base of cell R between arculus and origin of Rs. Venation: Rs very long, R correspondingly reduced; R_2 about in transverse alignment with r-m; petiole of cell M_3 nearly four times m-cu; vein 2d A long, gently sinuous.

Abdomen black. Male hypopygium (Plate 4, fig. 49) with basistyle terminating in three lobes, dorsal, *db*, shortest, obtuse and unblackened at apex, provided with setæ to tip; ventral lobe, *vb*, a little longer and stouter, tip obtuse; mesal lobe, *mb*, longest, heavily blackened, terminating in a blackened blade, margin before apex with a small lateral lobe or obtuse spine. Two dististyles, outer, *od*, a slender, nearly straight rod, basal half slightly more dilated but glabrous, distal half narrowed, terminating in an acute spine, surface back from tip with numerous appressed spinulæ. Inner dististyle, *id*, a sinuous blackened horn that narrows to a long, attenuate, acute point. Phallosomic structure a flattened plate, apex obtusely rounded, unarmed, surface with very delicate scattered setulæ. Ædeagus long, relatively slender.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 1,000 feet, May 23, 1938 (*Yankovsky*). Allotopotype, female. Paratopotypes, several of

both sexes, altitude 300 to 1,000 feet, May 19 to June 16, 1938 (*Yankovsky*).

In the structure of the male hypopygium *Molophilus* (*Molophilus*) *facinus* is very different from the other regional species that have the body coloration intensely black. As indicated under the preceding species, it is very similar to the latter, *M.* (*M.*) *monacanthus* sp. nov., yet very distinct.

MOLOPHILUS (MOLOPHILUS) AVIDUS sp. nov. Plate 1, fig. 24; Plate 4, fig. 50.

Belongs to the *gracilis* group and subgroup; general coloration plumbeous; antennæ short, basal segments obscure yellow, outer segments passing into brown; halteres yellow; legs pale yellowish brown, outer segments darker; wings subhyaline, veins a little darker than ground; male hypopygium with dorsal lobe of basistyle produced into two conspicuous curved spines; ventral lobe a small, pale, fingerlike structure; two simple dististyles, longest with appressed spinulæ on distal half; phallosomic plate pale, apex obtusely rounded, surface with abundant microscopic setulæ.

Male.—Length, about 4 millimeters; wing, 4.4 to 4.5.

Female.—Length, about 5 millimeters; wing, 5.4.

Rostrum and palpi brown. Antennæ (male) short, if bent backward not attaining wing root; basal segments obscure yellow, outer segments passing into brown. Head dark gray.

Pronotum brown, obscure yellow behind; anterior lateral pretergites yellow. Mesonotum almost uniformly grayish brown to plumbeous; scutellum obscure brownish yellow to testaceous; postnotum paler brown. Pleura pale brown, dorsal pleurites a little darker. Halteres yellow. Legs with the coxæ and trochanters obscure yellow; remainder of legs pale yellowish brown, terminal tarsal segments dark brown to brownish black. Wings (Plate 1, fig. 24) subhyaline, veins a little darker than ground; costal fringe dark brown, long and dense. Venation: R_2 lying distad of level of r-m; m-cu about one-fourth length of petiole of cell M_3; vein 2d A long, gently sinuous.

Abdomen brown, including hypopygium. Male hypopygium (Plate 4, fig. 50) with dorsal lobe of basistyle, *db*, produced into two spines, the outer a conspicuous curved spinous blade, with nearly the apical half prolonged mesad into a straight blackened spine; inner spine of lobe broad-based, terminating in a long slender point; ventral lobe of basistyle, *vb*, proximal in position, unusually slender and entirely pale. Dististyles,

outer, *od*, longest, appearing as a powerful, curved, blackened rod from an expanded base, distal half with appressed spinules, tip acute; inner style, *id*, sinuous, distal half with small punctures. Phallosomic plate, *p*, pale, apex obtusely rounded; surface with abundant microscopic setulæ.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 2,500 feet, June 17, 1938 (*Yankovky*). Allotopotype, female, pinned with type. Paratopotypes, 1 male, 1 female, with types; 1 male, altitude 1,800 feet, June 26, 1938 (*Yankovsky*).

Molophilus (*Molophilus*) *avidus* is quite distinct from all other regional species of the genus, differing primarily in the structure of the male hypopygium, notably the bispinous dorsal lobe of the basistyle.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d*, dististyle; *db*, dorsal lobe of basistyle; *dd*, dorsal dististyle; *g*, gonapophysis; *id*, inner dististyle; *mb*, mesal lobe of basistyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Limonia* (*Limonia*) *parvipennis* sp. nov.; venation.
2. *Limonia* (*Dicranomyia*) *parviloba* sp. nov.; venation.
3. *Antocha* (*Antocha*) *integra* sp. nov.; venation.
4. *Dicranota* (*Eudicranota*) *perdistincta* sp. nov.; venation.
5. *Limnophila* (*Elæophila*) *persalsa* sp. nov.; venation.
6. *Limnophila* (*Elæophila*) *serenensis* sp. nov.; venation.
7. *Limnophila* (*Adelphomyia*) *macrotrichiata* Alexander; venation.
8. *Limnophila yankovskyana* sp. nov.; venation.
9. *Rhabdomastix* (*Sacandaga*) *spatulifera* sp. nov.; venation.
10. *Rhabdomastix* (*Sacandaga*) *luridoides* sp. nov.; venation.
11. *Cryptolabis* (*Bæoura*) *septentrionalis* sp. nov.; venation.
12. *Ormosia* (*Ormosia*) *devota* sp. nov.; venation.
13. *Ormosia* (*Ormosia*) *cata* sp. nov.; venation.
14. *Ormosia* (*Ormosia*) *prava* sp. nov.; venation.
15. *Ormosia* (*Ormosia*) *yankovskyi* sp. nov.; venation.
16. *Ormosia* (*Ormosia*) *cornutoides* sp. nov.; venation.
17. *Ormosia* (*Ormosia*) *fragmentata* sp. nov.; venation.
18. *Erioptera* (*Erioptera*) *mediofusca* sp. nov.; venation.
19. *Erioptera* (*Erioptera*) *sex-aculeata* sp. nov.; venation.
20. *Erioptera* (*Ilisia*) *serenicola* sp. nov.; venation.
21. *Erioptera* (*Symplecta*) *chosenensis* sp. nov.; venation.
22. *Erioptera* (*Empeda*) *subnubila* sp. nov.; venation.
23. *Molophilus* (*Molophilus*) *monacanthus* sp. nov.; venation.
24. *Molophilus* (*Molophilus*) *avidus* sp. nov.; venation.

PLATE 2

FIG. 25. *Limonia* (*Limonia*) *parvipennis* sp. nov.; male hypopygium.
26. *Limonia* (*Dicranomyia*) *parviloba* sp. nov.; male hypopygium.
27. *Limonia* (*Dicranomyia*) *parviloba parvincisa* subsp. nov.; male hypopygium.
28. *Antocha* (*Antocha*) *integra* sp. nov.; male hypopygium.
29. *Dicranota* (*Eudicranota*) *perdistincta* sp. nov.; male hypopygium.
30. *Limnophila* (*Elæophila*) *persalsa* sp. nov.; male hypopygium.
31. *Limnophila* (*Elæophila*) *serenensis* sp. nov.; male hypopygium.
32. *Limnophila yankovskyana* sp. nov.; male hypopygium.

PLATE 3

FIG. 33. *Rhabdomastix* (*Sacandaga*) *nigroapicata* sp. nov.; male hypopygium.

FIG. 34. *Rhabdomastix* (*Sacandaga*) *spatulifera* sp. nov.; male hypopygium.
35. *Rhabdomastix* (*Sacandaga*) *luridoides* sp. nov.; male hypopygium.
36. *Cryptolabis* (*Bæoura*) *septentrionalis* sp. nov.; male hypopygium.
37. *Ormosia* (*Ormosia*) *devota* sp. nov.; male hypopygium.
38. *Ormosia* (*Ormosia*) *cata* sp. nov.; male hypopygium.
39. *Ormosia* (*Ormosia*) *prava* sp. nov.; male hypopygium.
40. *Ormosia* (*Ormosia*) *yankovskyi* sp. nov.; male hypopygium.
41. *Ormosia* (*Ormosia*) *cornutoides* sp. nov.; male hypopygium.
42. *Ormosia* (*Ormosia*) *fragmentata* sp. nov.; male hypopygium.

PLATE 4

FIG. 43. *Erioptera* (*Erioptera*) *mediofusca* sp. nov.; male hypopygium.
44. *Erioptera* (*Erioptera*) *sex-aculeata* sp. nov.; male hypopygium.
45. *Erioptera* (*Ilisia*) *serenicola* sp. nov.; male hypopygium.
46. *Erioptera* (*Symplecta*) *chosenensis* sp. nov.; male hypopygium.
47. *Erioptera* (*Empeda*) *subnubila* sp. nov.; male hypopygium.
48. *Molophilus* (*Molophilus*) *monacanthus* sp. nov.; male hypopygium.
49. *Molophilus* (*Molophilus*) *facinus* sp. nov.; male hypopygium.
50. *Molophilus* (*Molophilus*) *avidus* sp. nov.; male hypopygium.

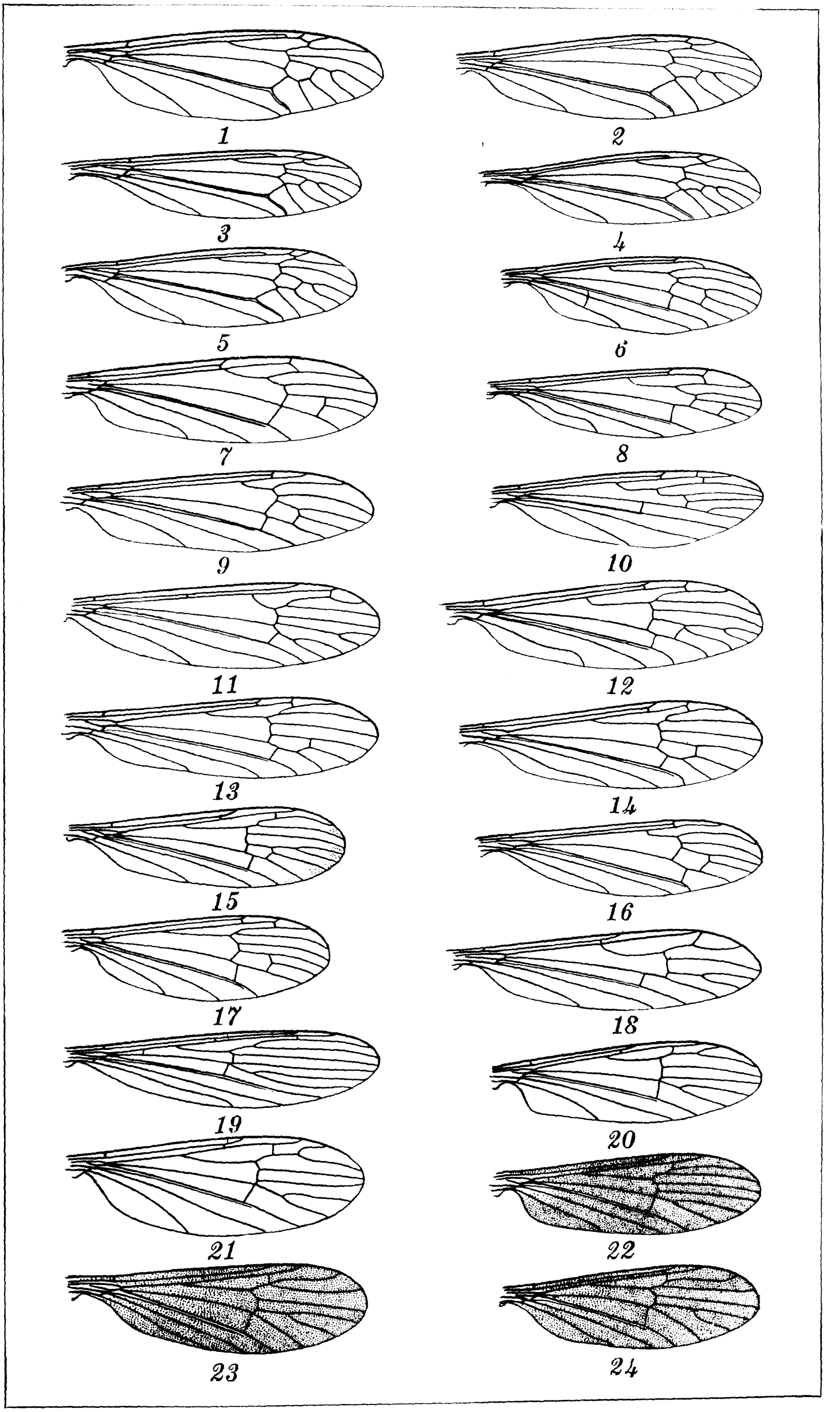

PLATE 1.

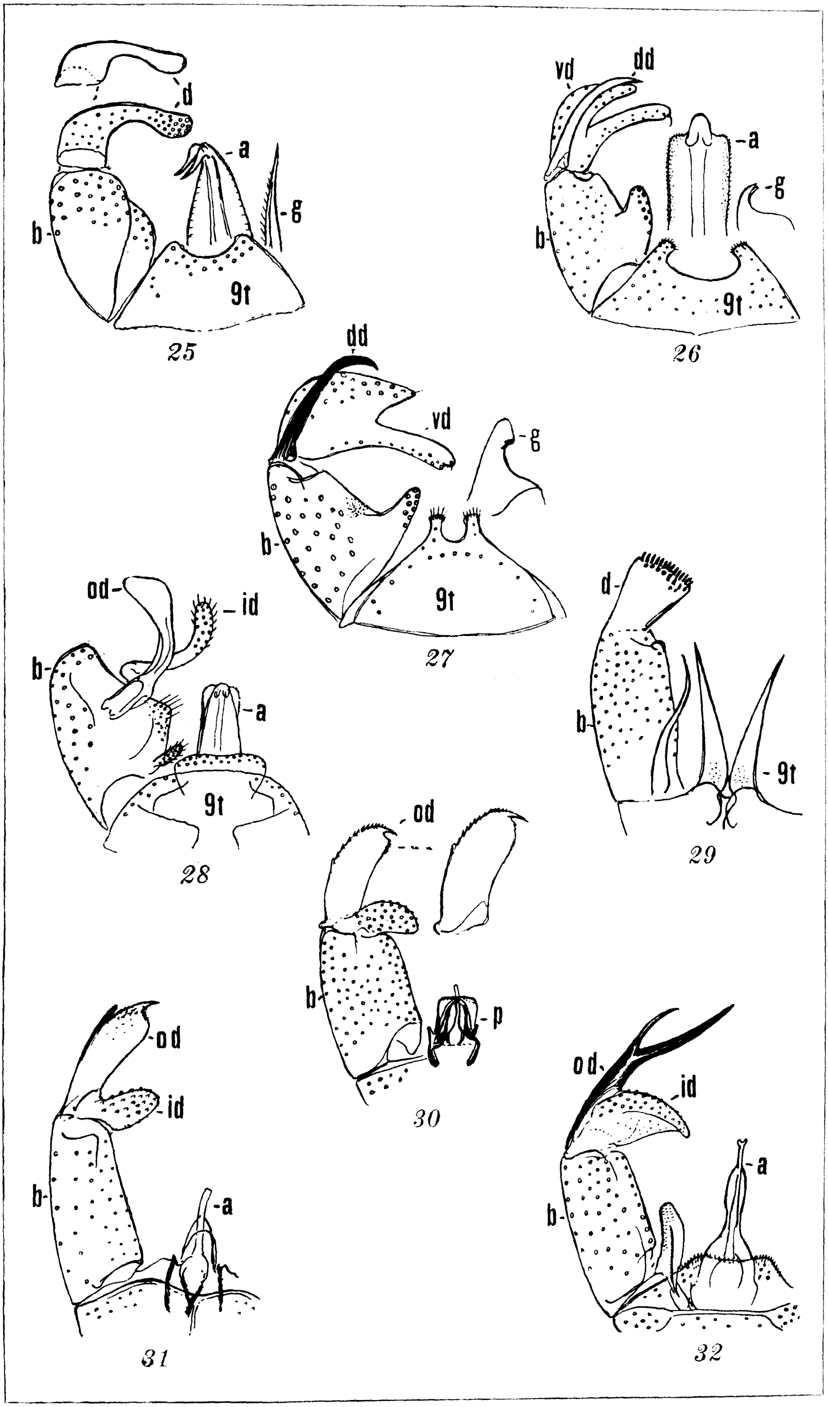
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PLATE 2.

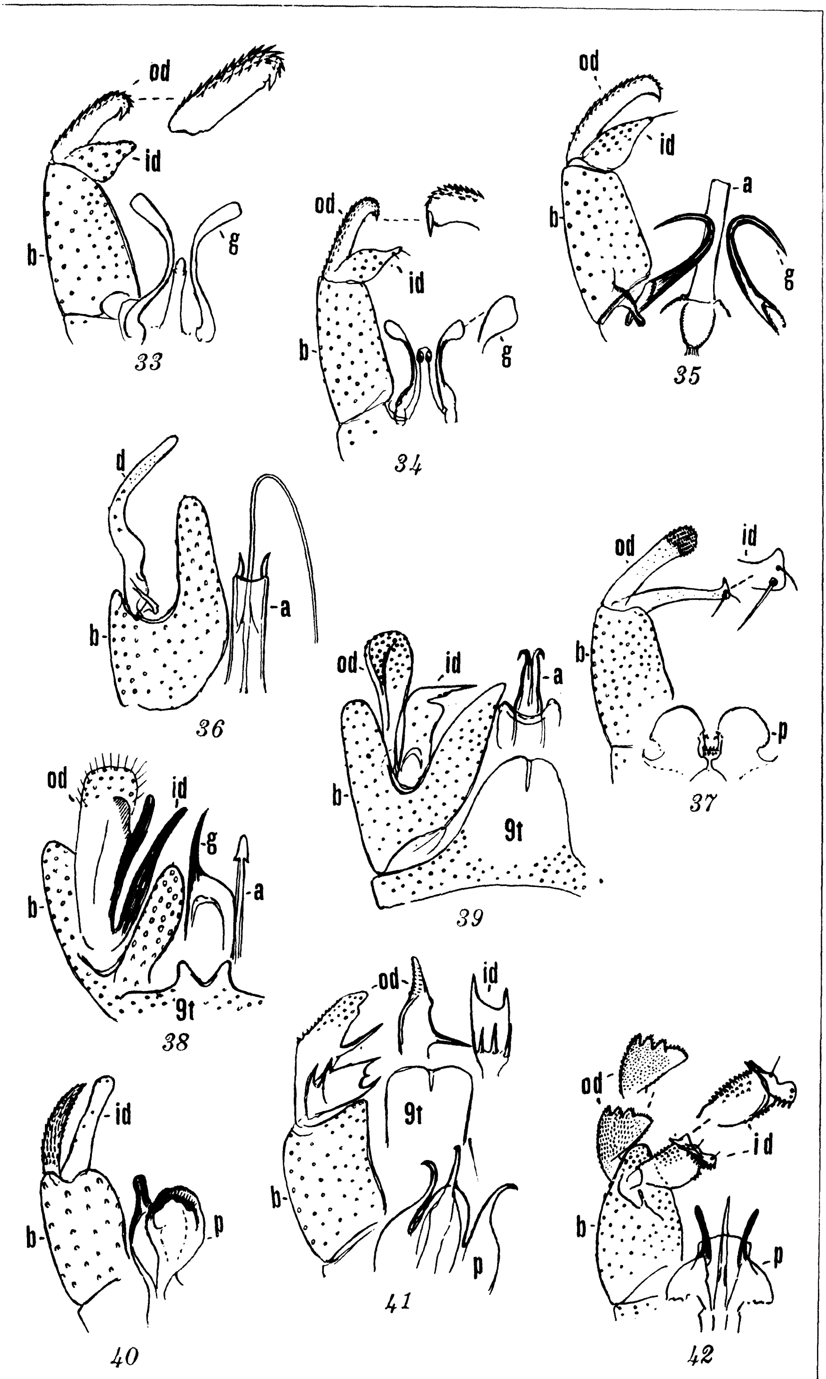

PLATE 3.

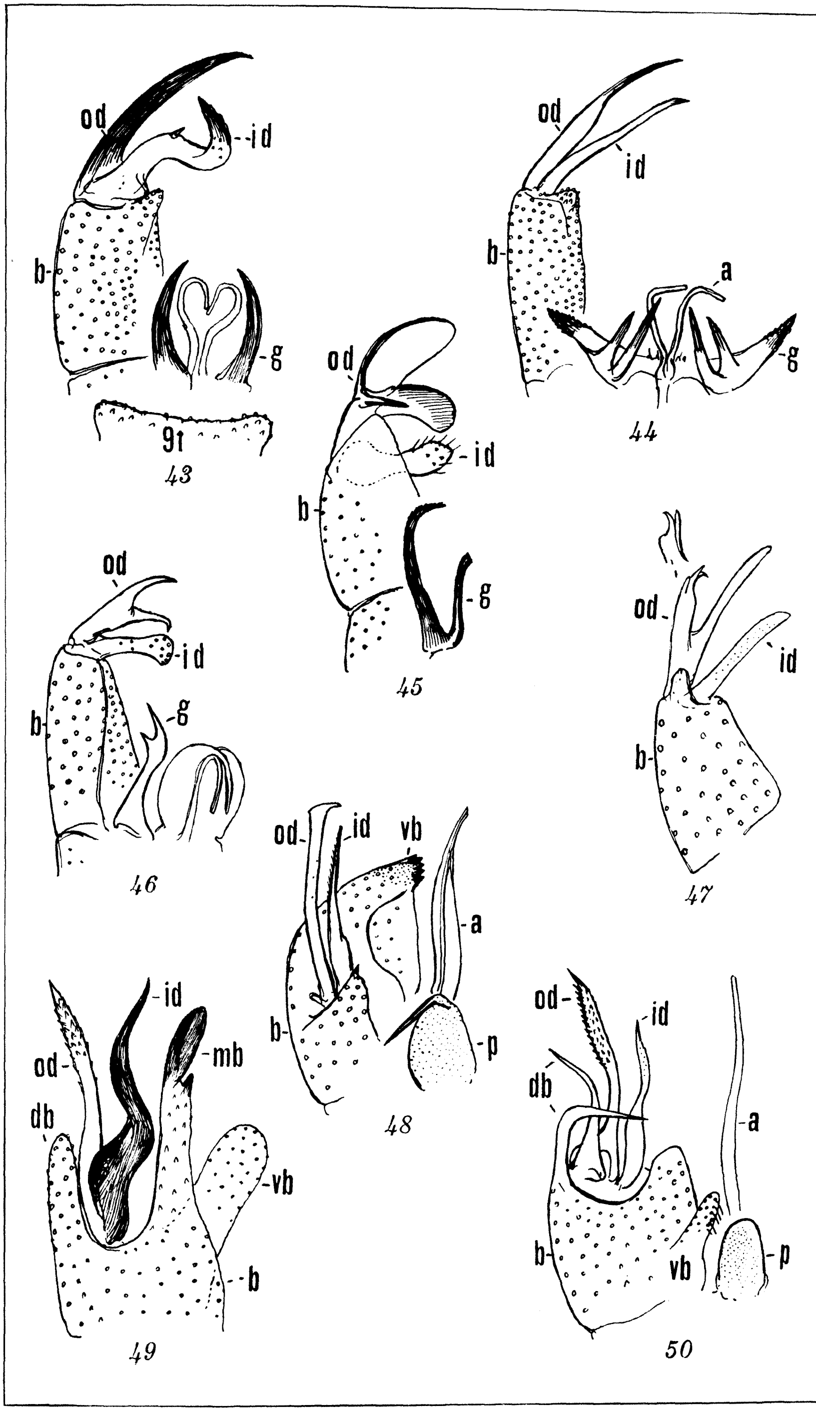
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PLATE 4.

A NEW FISH FROM LINGAYEN GULF, PHILIPPINES

By HILARIO A. ROXAS and GUILLERMO L. ABLAN

Of the Division of Fisheries, Department of Agriculture and Commerce Manila

ONE PLATE

Genus GNATHOLEPIS Bleeker (1874)

Body elongate, compressed, covered with 24 to 32 ctenoid scales, more cycloid but large on neck. Head compressed, scaled above after eyes and on preoperculum and operculum with large cycloid scales. Eyes large, in anterior half of head. Bony interorbital narrow. Snout short. Anterior nostril in a short tube. Mouth oblique, upper or lower jaw prominent. Teeth in rows, outer row enlarged, sometimes last teeth caninoid in lower jaw. Tongue truncate to scarcely bilobate. Gill openings not far continued forward below, isthmus narrow. Inner edge of shoulder girdle without fleshy flaps. Dorsal fins separate, first dorsal with 6 spines, second dorsal with 9 to 12 rays, anal with 9 to 12 rays, ventral united, oblong, under pectoral. Pectoral without free silklike rays. Caudal obtuse to rounded.

Herre (1927) found in some Philippine species of the genus, as deviations from those of Bleeker's description, notched tongue and pointed caudal.

In this paper is described one species of the genus which is very distinct from those so far described.

GNATHOLEPIS TURNERI sp. nov. Plate 1.

First dorsal VI; second dorsal I, 10; anal I, 10; 28 scales in longitudinal series, 8 in transverse series, 14 before first dorsal.

Body elongate; dorsal outline straight; ventral outline convex, compressed posteriorly from anal papilla, greatest depth 6, head 3.64 in standard length; snout blunt and rounded, 5 in head; eyes large, about equal snout, placed very high, dorsolateral, close together, only a narrow ridged bony interorbital separating the two; mouth oblique, jaws equal, posterior angle of maxillary in line with front margin of eye; teeth in several rows in each jaw, those of outer row enlarged, curved, exposed; tongue strongly notched; the whole fish covered with large thin scales,

three rows of scales on preopercle. Longest spine of first dorsal a little greater than longest ray of second dorsal which equals longest ray of anal; caudal long, pointed, longer than head, more than 2.93 in the length; ventrals elongate, rays not reaching anal; pectorals longer than head.

Alcoholic specimens dull grayish yellow with four indistinct blotches along side, two narrow yellowish bands below eye on preoperculum. Spinous and second dorsal checkered with grayish spots; ventrals and anal dusky, pectorals yellowish pale with distinct orange yellowish base, caudal grayish.

The new species approximates *G. davaoensis*, to which it is very close, in the number of rays in the first dorsal and anal, in having a bony interorbital ridge and strongly notched tongue. However, it differs remarkably from the latter in having fewer rays in the second dorsal, in having more predorsal scales, and in having a pointed caudal.

Here described from type specimen No. 41993, 116 millimeters long, included in the catch of the fishing boat "Laoag," collected by a beam trawl from Lingayen Gulf. The specimen is kept in the ichthyological collection of the Division of Fisheries, Department of Agriculture and Commerce, Manila.

Named in honor of James E. Turner, of Pangasinan Province, Philippines.

Measurements.—Total length, 122 mm; standard length, 91 mm; breadth of head at operculum, 14 mm; eye to gill opening, 12 mm; snout, 4.5 mm; depth of head, 15 mm; pectoral base, 5 mm; long pectoral rays, 11 mm; base of first dorsal, 11 mm; long rays of first dorsal, 17 mm; base of second dorsal, 26.5 mm; second dorsal to caudal, 16 mm; longest rays of second dorsal, 16 mm; longest rays of anal, 16 mm; first dorsal to second dorsal, 6 mm; breadth of body, 10.5 mm; depth of body, 17 mm; length of ventral, 18 mm; eye to first dorsal, 20 mm; ventral to anal, 23 mm; eye, 7 mm; posterior interorbital ridge to snout, 12 mm; base of caudal, 11 mm; caudal, 31 mm; head, 25 mm; snout, 5 mm.

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ILLUSTRATION

PLATE 1. *Gnatholepis turneri* sp. nov.

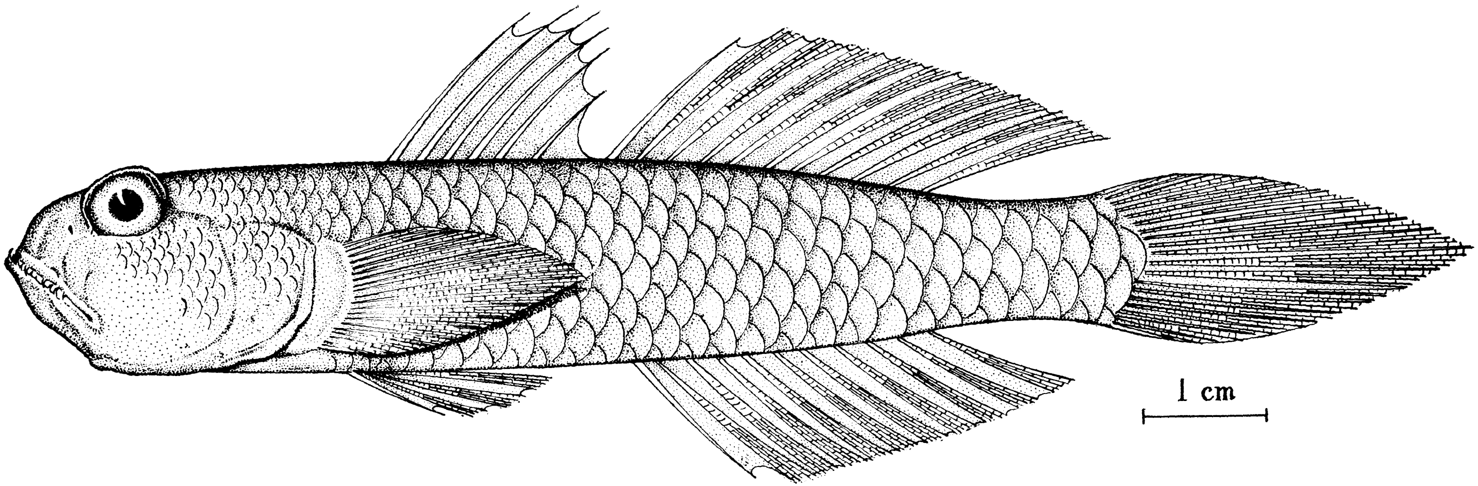


PLATE 1. GNATHOLEPIS TURNERI SP. NOV.

THE FISHERY INDUSTRIES OF ZAMBOANGA

By JOSE S. DOMANTAY

Of the Division of Fisheries, Department of Agriculture and Commerce
Manila

SIX PLATES AND SEVEN TEXT FIGURES

Zamboanga Province, including the recently chartered City of Zamboanga, has an area of 6,383 square miles. It occupies the entire peninsula projecting west of Pangil Bay to the south, including the island of Basilan, Olutanga, and some 150 smaller islets. It is bounded on the east by Occidental Misamis Province, Pangil Bay, and Lanao Province; on the south by Celebes Sea; and on the north and west by the Sulu Sea. It has several bays, the largest being Sibuguey Bay, Dumanquilas Bay, Pagadian Bay, and Sindangan Bay. Some of the smaller bays are Maligay Bay, Igat Bay, Port Sibulan, Tumalung Bay, Locsico Bay, Taba Bay, Busan Bay, Port Bañga, Tuñganan Bay, Taguite Bay, Caldera Bay, Sibuco Bay, Panabutan Bay, Siokon Bay, Port Santa Maria, Coronado Bay, and several others. In Basilan Island are Takut Tangug Bay, Look Sambang Bay, San Rafael Bay, and Maluso Bay. The entire coastline of Zamboanga Province is approximately 700 miles. All along the coast are shoals and extensive coral reefs and sandy and partly muddy shores.

The population of the province and of the City of Zamboanga is a mixture of Christian and non-Christian peoples, with the former slightly in the majority. The Christians, including foreigners, number 161,184, and the non-Christians, 106,829. All the non-Christians are fish-eating peoples, and the same is true of the majority of the Christian population. Roughly, over 90 per cent of the entire population of Zamboanga depends on fish as the principal protein in their diet.

The Port of Zamboanga serves as a distributing center of fish and other marine commercial products to different parts of the Archipelago. The physical condition and geographical location of the port, together with the type of people inhabiting

the region, make fishing an important industry in the locality. Getting a food fish supply is therefore no problem in any part of Zamboanga Province.

PRINCIPAL FISHING GROUNDS

Practically all waters around the province and the City of Zamboanga are rich fishing grounds with a great variety of fishes. The shoals, bays, coves, and mouths of rivers are rich shallow-fishing grounds. Off-shore areas are rich in different pelagic and demersal fishes.

The principal shallow-fishing grounds are around Dumanquilas Bay, Igat Bay, Port Sibulan, Tumalung Bay, Locsico Bay, the whole Masinloc Anchorage including the neighborhood of Sacol and Tictauan Island, Caldera Bay, Sibuco Bay, Panabutan Bay, Port Santa Maria, Sindanga Bay, Dipolog Shoal, and Dapitan Bay. At Basilan Island the principal fishing grounds are around Takut Tangug Bay, in the neighborhood of Bohelebong, Kauluan Island, the mouth of Kandiis River, and around Kapago up to Matanal point; Look Sambang Bay in the neighborhood of the mouth of Gubauan River; around San Rafael Bay in the neighborhood of Gumalarang River, Balatana Island up to Lampinigan Island; and Maluso Bay in the neighborhood of Maluso and Canabuñgan Rivers and including the surroundings of the Gounan Islets, Takela, and Goreno Islands, and many other places in the neighborhood.

The offshore sea fishing grounds are rich in all species of game and commercial fishes, like the yellowfin tuna, *Neothunnus macropterus;* the skipjack or ocean bonito, *Katsuwonus pelamis;* the frigate mackerel, *Auxis thazard;* the bonito, *Euthynnus yaito;* the Spanish mackerel, *Cybium commerson;* the barracuda, *Sphyræna aureo-flammea;* the runner, *Elagatis bipinnulatus;* and the carangoid, *Caranx* spp. (tarakitok). Other fishing grounds are Sibuguey Bay, Sulu Sea, Moro Gulf, and Celebes Sea. In Sibuguey Bay the best tuna-fishing grounds are around Olutanga Island and in the neighborhood of Angosto Shoal; in Sulu Sea, around Zamboanga Peninsula, is a good tuna fishing ground, particularly in the neighborhood of Sangboy Island; and in Moro Gulf and Celebes Sea. The whole neighborhood of Basilan Island is a good tuna-fishing ground.

FISHING GEAR, CRAFT, AND METHODS OF FISHING

With the exception of the modern fishing boats used for tuna fishing in deeper waters by the Sea Foods Corporation, the equipment and gear used in the fisheries of Zamboanga are of primitive type, apparently used for the last century. Though usually home-made, they are well constructed and suited to meet local conditions. The most common craft is the banca, locally called *vinta,* which is a paddled or sailing dugout usually equipped with two outriggers. It is seaworthy and capable of considerable speed when the sail is used. It is always equipped with the most primitive implements of fishing, like the spear, a larger hooklike implement attached to a long, light pole that is detachable and tied by a strong cord. This spear also serves as a hook for catching large fishes and sharks. The three-tooth prong, called "salapang," with a long handle, is also commonly used by the Moro fishermen. A hook and line are almost always part of the fishing equipment. A "barroto" is usually a bigger dugout, used in connection with the more modern type of fishing nets, the "chinchorro" and "baling."

FISH TRAPS

Fish corral.—The fish corral is the most common fishing apparatus used and is always found on sheltered coastlines and shoals. It is locally known as *bunsod.* Except in a few cases the bunsod is of one type and style. It is a partly modified *pahubas* type. It is a temporary bamboo corral, set on flats or gradually sloping shores to catch fish frequenting the intertidal zones. It varies in size from a small to a large inclosure, covering several hundred square meters in area. It usually consists of three heart-shaped compartments; the *bunuan,* the *sagaran,* and the *kaluagan,* with two wings called *pikpik* and a leader called *pamansan.* Text fig. 1 is a diagram of this common and typical bunsod.

Except for those constructed around Takut Tangug Bay in the neighborhood of Bohelebong and Kauluan Island, bunsod are constructed out of temporary materials, usually supported by small wooden piles with bamboo matting (*sigid*), tied together by small strips of rattan or vine *diliman.* It is said that the vine lasts longer than the rattan in sea water. In the neighborhood of Bohelebong and Kauluan Island, around Takut Tangug Bay, most of the bunsods are constructed with

large *pagatpat* wooden piles, with the usual bamboo matting tied together by rattan. The large wooden piles or posts are said to last as long as ten years, so that only the bamboo mattings need to be reinforced when they are damaged. Most of these fish corrals are constructed in waters from 4 to 10 meters deep and are of different shapes and styles. The bunsod catches many different kinds of large fishes, like the ocean bonito (*Katsowonus pelamis*), bonito (*Euthynnus yaito*), Spanish mackerel (*Cybium commerson*), carangoids (*Caranx* spp.), runner (*Elagatis bipinnulatus*) and others. It is claimed that some fish corrals catch from 500 to 10,000 tuna fish at one time. The difference in the plan and shape of these bunsods in this region depends on their location and relation to the different islets, shoals, and fish corrals found within the bay. In spite of the strong materials used and the depth where they are constructed it is said that in most cases the cost of construction is less than 100 pesos.[1] Text fig. 2 shows diagrams of the different shapes and plans of bunsods in this locality.

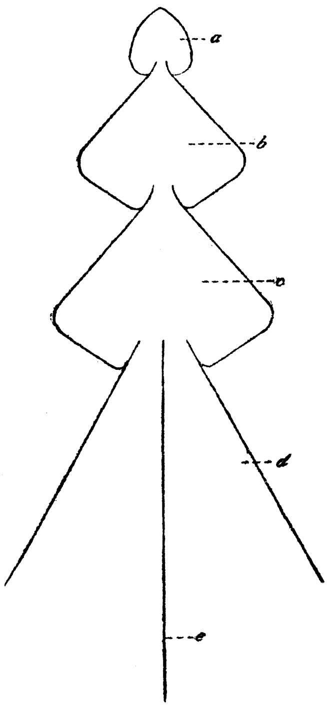


FIG. 1. Bunsod fish corral, *a*, bunuan; *b*, sagaran; *c*, kaluagan; *d*, pikpik; *e*, pamansan.

In all cases the three compartments are always present, though differently arranged in the typical order. In some cases the pikpik are absent and a part of the walls of the kaluagan serves their purpose; in other cases the pamansan is absent. Still in others both pikpik and pamansan are absent.

In all of these fish corrals the fishes are usually impounded either in the bunuan or in the sagaran. The fishes are caught by the use of siguid, with the help of a large bamboo basket raised up after the fishes are all driven into it. In some bunsods a small net, called *pukot* or *rede,* is used to gather the fishes from the kaluagan.

Another form of fish corral found in Dipolog and neighboring places is the *paugmad,* similar to the *linati.* It is of

[1] One peso equals 50 cents United States currency.

the simplest type, usually constructed in waters from 8 to 10 fathoms deep. It has the form of an anchor, and, excluding the leader, is crescent-shaped. It occupies an area of about half a hectare, usually constructed of and supported by long and large bamboo poles. Similar materials are placed at right angles to these supports tied together with rattan. Some of the fish

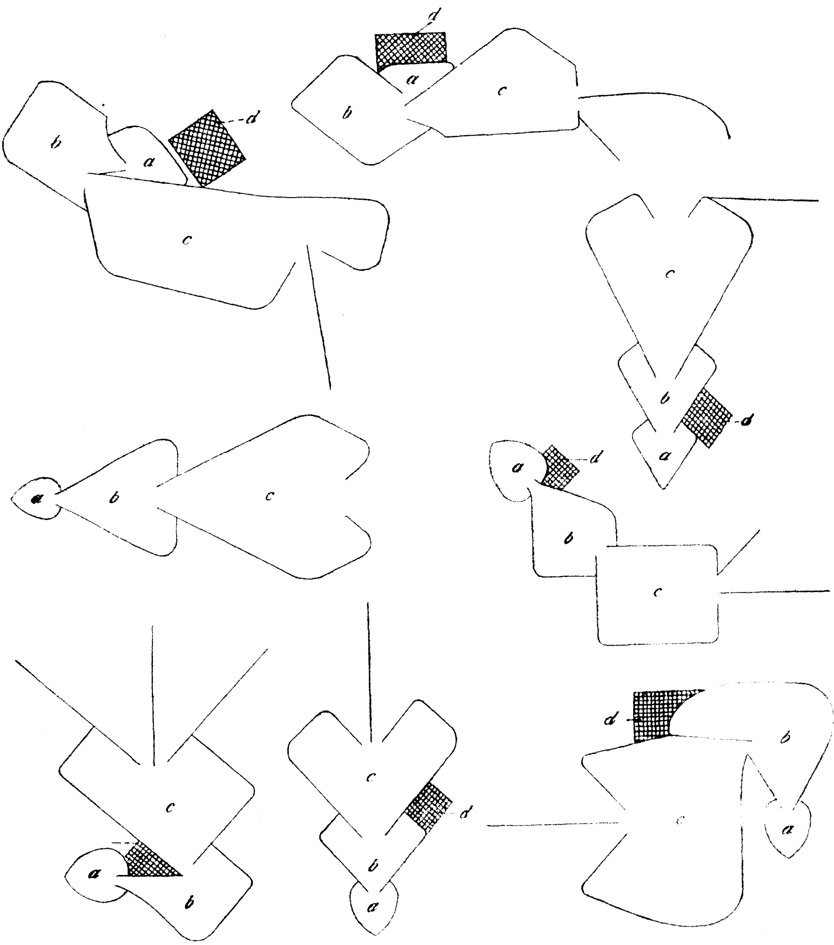


FIG. 2. Variations of the bunsod. *a*, bunuan; *b*, sagaran; *c*, kaluagan; *d*, hut.

corrals are reinforced with a few coconut trunks. Along the sides are coarsely woven bamboo lattices of about 4-inch mesh, tied to the supports and framework with strips of rattan. At the two ends of the paugmad are bamboo platforms used for spreading and drying the net, called *sigin*. At the vertex of the anchorlike enclosure or at the side of one arm is usually a

small hut where the fishermen may watch for the entrance of large fishes to haul them in before they have a chance to escape. A few meters from the surface of the water, along the entire wall of the fish corral, are side platforms made of one or two large bamboos from where the fishermen drag the sigin during actual hauling of the net. From the middle of the gate a series of bamboo piles extends toward the shallow part, near the shore, which serves as a leader. This series of piles is called *tulis.* Inspite of the absence of a gate the fishes do not easily escape once they are inside. Even small fishes, like sardines, cannot usually get out of the corral through the large mesh openings of the bamboo mattings.

A paugmad can be constructed at a cost of from 200 to 250 pesos, excluding the accessories in the form of sigin and the banca. The fishes inside the fish corral are usually caught by a small seine, called *sigin,* which is provided with lead weights along the lower edge and wooden floats at the upper edge and pull ropes on all sides. This net is usually dropped from either end of the fish corral, whence it is worked to the opposite end. The weighted side is hauled up, so as to convert it into a large dip net. The hauling is done every three or four hours of the day and at any time when a school of fishes enters the corral. Often the hauling is guided by a current indicator placed under the guard house or hut. The fishermen usually make the haul when there is very slight current or no current at all.

Unlike the bunsod in the neighborhood of Bohelebong and Kauluan Island of the Takut Tangug Bay, the paugmad of the Dipolog fishing grounds and neighboring places last only for six months, from January to June. All paugmad are usually destroyed at the onset of the southwest monsoon and they have to be reconstructed every year. Text fig. 3 is a diagram of the paugmad type of fish corral.

Another type of fish corral is the *pahubas,* which is more or less like the ordinary bunsod of the Moro fishermen. It is a small fish corral with two heart-shaped compartments, the bunuan and the sagaran, and with two wings and a leader. Here the walls, wing, and leader are all lined with closely woven bamboo matting (siguid). This fish corral is usually constructed close to the shore at a depth of from one to two fathoms, and can be easily transferred from one place to another. After the fishing season the materials used are removed and kept for the

following year, if they are not transferred to other favorable places. The cost of construction ranges from 100 to 200 pesos, depending on the size.

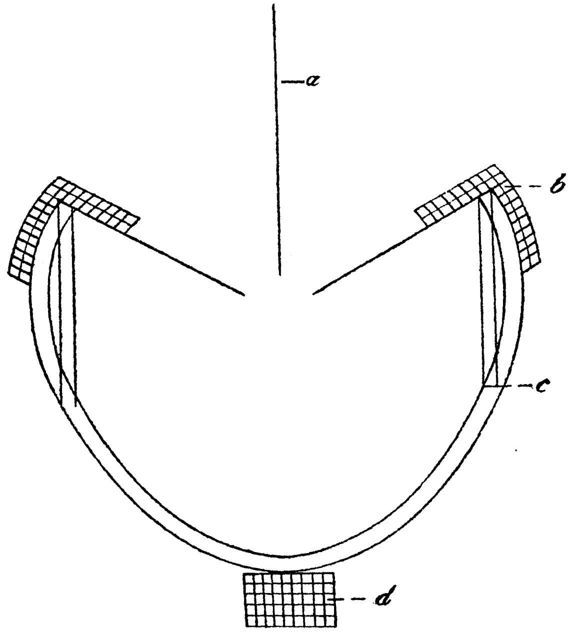


FIG. 3. Paugmad fish corral. *a*, tulis; *b*, bamboo platform; *c*, platform consisting of a single piece of bamboo for dragging the sigin; *d*, hut.

A small banca or bamboo raft, together with a small abaca net about 3 meters long and 1 meter wide, are used in catching fish in this type of fish corral. The small abaca net with a bamboo pole at each end is used to scoop the fishes from the two chambers, from the sagaran to the bunuan. Two men manipulate the poles of the net, while another, in the water, holds the net to the bottom. The catch is dropped or emptied into a large bamboo basket. The operation is repeated at least three times until all the fishes are caught.

The catching of fish inside this corral is done at least two or three times a day. Text fig. 4 is a diagram of the pahubas type of fish corral.

Saluran, a fish corral similar to the ordinary pahubas, is constructed on rocky or corral reef shoals or on the shore. A fishing light is usually used in conjunction with it to attract the fishes.

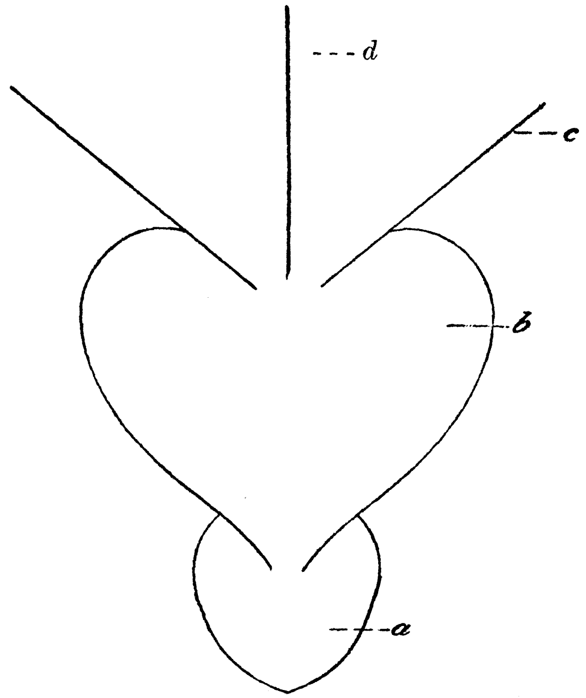


FIG. 4. Pahubas fish corral. *a*, bunuan; *b*, sagaran; *c*, pikpik; *d*, tulis.

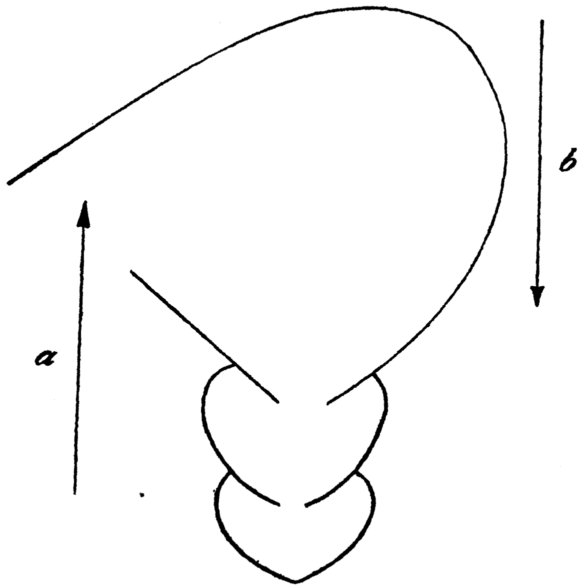


FIG. 5. Balerong fish corral. *a*, direction of flow at low tide; *b*, direction of flow at high tide.

Another type of small fish corral is the *balerong*, usually constructed along the sides or near the mouths of rivers for catching fishes that go upstream during high tide. During low tide the fishes are usually caught when they go back to the sea. The balerong is made of small wooden piles with finely woven bamboo mattings serving as a wall, the fishes caught inside the bunuan being scooped out with a dip net. Text fig. 5 is a diagram of the balerong.

Panera is another small-river fish corral, usually made of small wooden piles of fine bamboo mattings. It is usually placed along the side of a river at the mouth of a small creek in a swampy region. It may or may not have wings, depending upon the condition of the place. It may have one or two heart-shaped chambers. This type is used at the gate of all fishponds of the Ilongo type. During high tide fishes from the river usually go to the swamps and creeks, and when the water recedes they are caught on their return to the river through the creek inside the panera. The fishes are usually taken out of the corral by dip nets. Text fig. 6 is a diagram of the panera.

Tancub is another type of small fish corral, more or less similar to the pahubas, usually constructed near the mouth of a river or along the shores of enclosed bays. It is made of a series of small wooden piles with bamboo mattings, called *banata*, as walls. As in the other small fish corrals, the fish are collected in the terminal pound and are usually fished out with the *sigid* and a dip net or dip basket, called *sihud*.

The *ampas* is a modified fish trap composed of a *bobo* and a *lugo* and several pieces of coarsely woven bamboo matting joined together to form the wings. These are in the form of a letter V, leading to the terminal pound, the bobo. The bobo is usually placed in a shallow shoal among corals or rocks. A lugo, a triangular fish trap open at both ends, is placed at the entrance to the bobo with its smaller end firmly fixed to avoid the escape of fish from the junction of the two. From the side of the mouth of the lugo and extending almost to the shore are the coarsely woven bamboo mattings supported by a few small wooden piles serving as wings of the lugo. Except for the portion of the bamboo matting close to the shore, the fish corral is under water and is apparently intended for catching bottom-dweller fishes. In hauling the

catch, the bobo is detached from the lugo and brought up to the surface. In some places a pukot is used in the place of the bobo, and in the place of the coarsely woven bamboo mattings a series of coconut leaves strung to a long rope is used. The fishermen use this device to drive the fishes inside the enclosure. Text fig. 7 is a diagram showing the plan of the ampas.

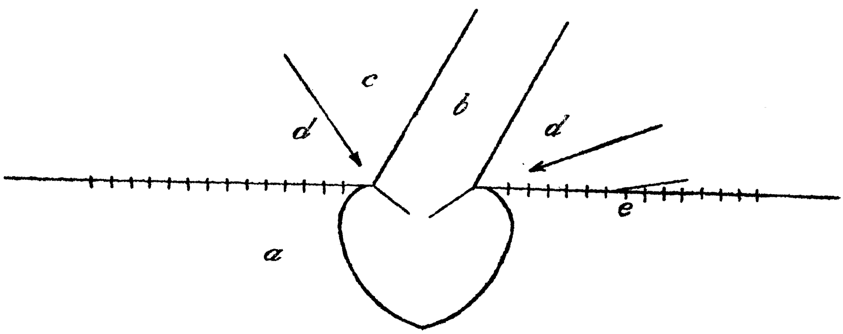


FIG. 6. Panera, river fish corral. *a*, river; *b*, creek; *c*, swamp; *d*, flow of water during low tide; *e*, wing of the panera or usually a bank of the river.

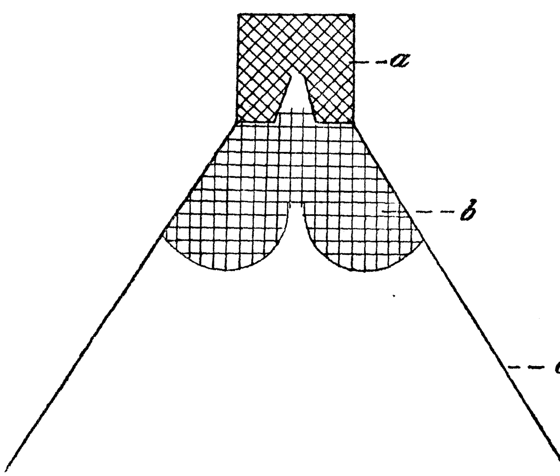


FIG. 7. Ampas fish corral. *a*, bobo; *b*, lugo; *c*, coarsely woven bamboo matting.

The bobo is the most common fish trap used by the Moro fishermen. It is usually a rectangular woven bamboo basket with an opening at one end provided with a long funnel-shaped piece of bamboo netting, called *galao*, to prevent the

fish from escaping once they are inside. In width and length the bobo varies from 1 to 3 meters, and in height from 0.5 to 1 meter. The shape is characteristic of the Moro type, which is different from bobos found in other places of the Philippines. The larger bobos are placed in deeper waters.

FISH NETS

Among the different fishing nets used, *chinchorro, baling, rede, pukot, lantao, atarraya, sakag,* and *salap,* are the most common.

Chinchorro.—The chinchorro is undoubtedly the most efficient fishing gear used along northern Zamboanga, where it has been introduced by the Visayan and Tagalog fishermen. Only few fishermen are using this net, which consists of a comparatively long conical pocket flanked by two long tapering wings of equal size. It varies a great deal in dimensions and is made up of several pieces cotton netting sewn together along the sides. A vertical wooden spreader, slightly shorter than the width of the wings at either extremity, is attached to the short extensions of the marginal ropes to prevent the wings from collapsing when dragged. Each spreader carries a bridle to which a long warp or pull rope is tied. Wooden cylindrical floats are evenly distributed along the float line and seamed by separate cords about 20 centimeters apart. Strung along the head line at regular intervals are lead weights in sufficient numbers to keep the net hung vertically when dragged. A stout cord is tied around the open end of the bag.

A chinchorro around 250 meters long may cost from 600 to 800 pesos and usually lasts for several years. This net is effective for catching fishes which do not come in large schools.

Baling.—The baling is a seine which is similar to the chinchorro in style and method of operation. The only difference is that it is made of abaca cloth. A baling around 250 meters long may cost from 300 to 500 pesos. Undyed baling may last only a few months. Some fishermen believe that undyed baling is more effective in catching fish than the dyed nets. This net is considered effective for catching small fishes, like anchovies and sardines which appear in large schools.

Rede.—The rede is similar to the chinchorro in materials and shape but much smaller, and the nettings are locally made. It is used on sandy-muddy shoals or shores and in some fishponds. It is a miniature chinchorro without a pocket.

Pukot.—The pukot used by the fishermen in Margosatubig and neighboring localities is different from that used in Luzon and the Visayas. It is a miniature baling, and sometimes called *basnig.* It is made of abacá cloth, from 20 to 40 meters long and about 2 meters deep, with a pocket about 10 meters long. It is usually operated in connection with a fishing vinta with a light which attracts and leads fish gently from the deeper waters to the shallower region where this pukot is placed and manipulated by one or two fishermen.

Lantao.—The lantao is a small gill net or miniature bating of the Tagalog fishermen. It is usually placed in fairly deep water across the current.

Atarraya.—The atarraya is a cast net sometimes known as *laya.* It is similar to the *dala* of the Tagalog. A moro fisherman poised in the prow of his vinta with the net properly arranged over his arm and shoulder throws the net over a school of fish. The forward portion of the net hits the water first, and the hind part, which is spread over the projected bamboo outrigger, follows. The vinta is paddled backward, dragging the rear portion of the net as far as possible to increase the scope of the apparatus. The casting of the net and the backward movement of the vinta are performed simultaneously with mechanical precision. This method calls for the help of two fishermen who dive immediately to drive the fishes within the scope of the net. The net is hauled up and slung across a cross piece to facilitate the removal of the catch.

Sakag.—The sakag is usually of $\frac{1}{4}$ inch mesh net, locally made. It is fastened to two bamboo poles crossed near one end and each provided with a small wooden shoe at the extremity. It is usually used on sandy beaches or inside fishponds, and pushed in front of the man who operates it.

Salap.—The salap is similar to the *sagap* of the Visayas. It is a small hand net, about 5 meters long and 1.5 meters wide, made of abacá cloth and strengthened along the four borders with abaca twine. The upper and lower margins are each attached to a stout abacá cord for holding. There are neither weights nor floats, so that either cord may serve as the bottom line. This net is used in catching bañgos fry in very shallow waters along sandy shores by two persons who hold the marginal cords at the corners and drag the net. It is also used for catching smaller fishes, like small mullets, in every shallow waters near the shore.

Ampis.—The ampis is another net made of abacá cloth and used in catching small shrimps of the genus *Palæmon,* locally called *baling* or *alamang.* It may be used in two ways. During high tide, when a school of small shrimps are seen inside the swamp, the ampis is stretched across the passage, so that during low tide when they are carried back to the sea, the shrimps are all caught. At other times, when shrimps are sighted the fishermen on a banca go after them and catch them with the ampis. The ampis is about 10 meters long or longer and 2 meters wide. It is a simple net, closely resembling the salap.

LUMINOUS LAMPS

Luminous lamps are the most common apparatus used in fishing in many places around Zamboanga Province. They are of various makes and vary from 600 to 1,800 candle power. In Margosatubig they are usually used in connection with the pukot. In other places they are used in hook-and-line fishing. Many fishermen abuse the use of luminous lamps in connection with the illegal use of poisonous substances, like *lagtang* or *tubli.* It is for this reason that the Municipality of Dipolog has passed an ordinance prohibiting the use of luminous lights in fishing.

FISHPONDS

The fishpond fishery, though not yet fully developed in Zamboanga Province, receives much attention, inspite of the abundance of fish caught in the sea. There are so far 12 fishponds under operation, and many more are being constructed or under application. All these fishponds, which vary from a few hectares to 176 hectares in size, are of the Ilongo type. With the exception of two, which are also of the Ilongo type, and one of semi-Malabon type, all are usually one-compartment enclosures irrespective of size. A one-compartment fishpond is perhaps better considered a mere fish trap, for it depends solely upon the fishes that enter the fishpond during high tide and are later caught during low tide by a small fish corral called *banata* (panera) (Plate 1, fig. 2; Plate 3, fig. 1). The dikes are poorly constructed, usually leaking, and the ponds are provided with one or two or more wooden temporary gates (Plate 1, fig. 3). At the gates are small fish corrals of the panera type, commonly called banata, which catch the fishes during the lowest tide of the new and full moon only. The fishes that are usually caught from these fishponds are the mullet (*lizas*), milkfish (*bañgos*), tarpons (*buan-buan*), spade fishes (*kitang*), bar-

TABLE 1.—*A list of the fishponds of Zamboanga Province.*

Permittee.	Site.	Area.	Remarks.
		Hectares.	
Adaza, Victor	Lumatig, Dapitan	2.29	Expired Dec. 31, 1930.
Alfaro, Celestino	Mercedes, Zamboanga	2.15	Under construction.
Angeles, Manuel	Kalugusang, Lamitan	13.00	In operation.
Anito, Eufemio	Dinas, Zamboanga	13.00	Under application.
Aguilar, Juan	Tumaguid, Lamitan	12.00	Expired Dec. 31, 1930.
Araneta, Antonio	Mulumuluan, Mercedes	5.96	In operation.
Araneta, Francisco	do	9.00	Under application.
Arquiza, Ignacio	Yati, Talontalon	22.00	In operation.
Baling, Ricarda (Mrs.)	Asinan, Boalan	13.50	Do.
Barte, A. L.	Camiton, Siocon	1.00	Under construction.
Do	do	1.00	Under application.
Binosa, Pilar	Limbaguhan, Kabasalan	10.00	Do.
Buenbrazo, Mariano	Corillera de Putol, Tetuan	11.00	Under construction.
Caboverde, Q.	Talon-talon, Zamboanga	3.00	Do.
Cainglit, Mrs.	Kabaslan, Zamboanga		Under application.
Dignadice, Emiliano	Labangan, Pagodian	200.00	Do.
Dalmon, Victoriano	Das-das, Dipolog	1.90	Expired Dec. 31, 1930.
Doromal, Alfredo	Palawan, Dapitan	11.00	In operation.
Enriquez, Ramon	Cabaluay, Bolong	10.53	Do.
Evangelista, Gregorio	Salinas, Talon-talon	176.00	Do.
Francisco, Jaime	Asinan, Boalan	9.00	Under application.
Gregorio, Juan	Cabaluay, Taluksañgay	9.25	Under construction.
Locson, Francisco	Yati-Talon-talon	10.50	In operation.
Marcelo, Jesus	Gampis, Sindangan	3.63	Under construction.
Macapagal, Quirino	Zamboanga	23.00	Do.
Ortega, Paciano	Tyloy, Dipolog	12.80	Auctioned for public bidding March 28, 1938.
Quebral, Medardo	Taluksañgay	5.50	Under application.
Payat, Juan	Talon-talon	36.80	Transferred to Julio Cabato. (Under construction.)
Ramos, Y. Leoncio Cesar	Dipolog	16.77	In operation. Permittee deceased.
Ramos, Restituto	Talon-talon	22.60	In operation.
Rebollos, Angel	Manicaan, Zamboanga	3.60	Under construction.
Reyes, B. Honorato	Taluksañgay, Zamboanga	6.56	Under repair.
Reyes, Placido de los	Sibucao, Talontalon	18.90	In operation.
Reyes, Andres	Mampang, Talon-talon	50.00	Under application.
Rico, Macario	Baid-baid, Bolong	20.00	Do.
Saavedra, Inocencio	Mercedes	6.20	Do.
Salle, Optociano	Dipològ, Zamboanga	25.90	Under construction.
Santos, T. de los	Cabaluay, Manikaan Bolong	4.60	Under application.
Tarroza, Salvador	Cabaluay, Bolong	12.75	In operation.
Torribio, Eugenio	Zamboanga	0.80	Under construction.

racuda (*rompecandado*), slipper (*kapalo*), siganids (*samaral*), snappers (*mangagat*), groupers and sea basses (*lapulapu*), some carangoids (*tarakitok*), shrimps (*baliskugay* and *lokon*), crabs (*alimango*), and others. The crabs are caught by means of bamboo traps, called *nasa* (Plate 2, fig. 3), which are usually baited with dead fish.

TABLE 2.—*Data on marine and shallow-water fisheries of Zamboanga with the registered fishing gear for 1937.*

Municipality or municipal district.	Fishing gear. Kind.	Number.	Operators.
Dapitan	Pahubas	21	Christians.
	Paugmad	1	
	Saluran	5	
	Rede	8	
	Fishing light [a]	5	
Dipolog	Baling	4	Do.
	Balirong	3	
	Pahubas	4	
	Panera	2	
	Paugmad	18	
Kabasalan	Fish corrals	8	1 Christian and 7 Moros.
	Fishing light	8	Moros.
	Pukot	1	Chinese.
	Lantao	1	Moro.
	Rede	1	Christian.
Katipunan	Baling	16	Christians.
	Chinchorro	2	
Margosatubig	Fish corrals	45	4 Christians and 41 Moros.
	Fishing light	136	131 Christians, 2 Chinese, and 3 Moros.
	Pukot	18	16 Christians, 1 Chinese, and 1 Moro.
	Ampis	9	2 Christians and 7 Moros.
Pagadian	Fishing light	30	26 Christians, 3 Moros, and 1 Chinese.
	Fish corrals	46	19 Christians and 27 Moros.
	Pukot	7	6 Christians and 1 Moro.
Sindañgan	Fish Corrals	7	Christians.
	Pukot	7	5 Christians and 2 Chinese.
Siocon	Fish corrals	7	5 Moros and 2 Christians.
	Bobo	1	Moro.
	Chinchorro	3	2 Christians and 1 Moro.
	Net (baling)	4	2 Christians and 2 Moros
Zamboanga City:			
Bolong	Fish corrals	8	5 Moros and 3 Christians.
	Tancub	9	5 Christians and 4 Moros.
Isabela de Basilan	Fish corrals	1	Moro.
	Rede	2	Moros.
	Atarraya	4	3 Moros and 1 Christian.
	Lantao	6	Moros.
	Pukot	1	Moro.
Lamitan	Fish corrals	6	Moros.
	Pukot	1	Christian.
	Ampis	1	Moro.
	Atarraya	1	Do.
Maluso	Fish corrals	4	Moros.
	Lantao	3	Do.
Taluksañgay	Fishing light	31	19 Christians and 12 Moros.
	Fish corrals	35	31 Moros and 4 Christians.
City proper	Atarraya	6	Moros.
	Fish corrals	26	18 Christians and 8 Moros.

Total number of fishing gear.

Pahubas	25	Baling	20
Paugmad	19	Panera	2
Saluran	5	Balirong	3
Fishing light [a]	205	Fish corral	193
Redes	11	Chinchorro	5
Ampis	9	Pukot	35
Bobo	1	Lantao	10
Tancub	9	Atarraya	6

[a] Accessory to other gear.

The only fishpond properly constructed is that of the late Dr. Cesar Ramos, of Dipolog, who came from Bulacan Province. It is a semi-Malabon type or a Malabon-Ilongo fishpond. The largest fishpond of Mr. Gregorio Evangelista, which is around 176 hectares, is being modified partly for raising milkfish in accordance with the suggestions given by the writer. This fishpond together with that of Mr. Ignacio Arquiza (Plate 3, fig. 1) are the only ponds with more than one compartment. Table 1 gives a list of the fishponds of Zamboanga Province, and Table 2 gives the marine and shallow-water fisheries of the province for 1937.

DEEP-SEA FISHING

Deep-sea fisheries around Zamboanga have lately been exploited by the fishing boats of the Sea Foods Corporation which started to use two fishing boats of 40.57 gross tonnage and 27.59 net tonnage each. Lately two other boats of 23.99 gross and 16.31 net tonnage, respectively, were added. These boats were registered as "Sea Foods No. 1," "Sea Foods No. 2," "Sea Foods No. 3," and "Sea Foods No. 5." The Company so far is using 106 men, distributed as follows: Sea Foods No. 1—15 Japanese fishermen-instructors, 1 Japanese cook and boy, 22 Filipino student fishermen, and 2 Filipino officers; Sea Foods No. 2—15 Japanese fishermen-instructors, 1 Japanese cook, 1 Japanese boy, 19 Filipino student fishermen, and 2 Filipino officers; Sea Foods No. 3—4 Japanese fishermen-instructors, 19 Filipino student fishermen, and 2 Filipino officers; Sea Foods No. 5—1 Japanese fisherman-instructor and 2 Filipino officers. Sea Foods No. 5, which has just been reconstructed after its acquisition, is being manned by fishermen from the other three fishing boats pending the appointment of new Filipino student fishermen. Lately, because of the strict enforcement of customs regulations, the number of Filipino student fishermen was reduced in all the fishing boats. The regulation providing that with the expiration of the 2-year term allowed the Japanese fishermen, only very few of them may be allowed an extension, tends to reduce the number of Japanese fishermen.

The monthly maintenance cost of the four fishing boats is around 1,300 pesos, including salaries, personnel, fuel, and fishing materials. The approximate cost of the fishing boats, including hull and engine, is 10,000 pesos each.

The tuna-fishing grounds around Zamboanga Province are Sibuguey Bay around Olutanga Island and the neighborhood

of Angosto Shoal; Moro Gulf in the neighborhood of Basilan Island; and Sulu Sea around the western side of the Zamboanga Peninsula, particularly in the neighborhood of Sangboy Island up to Port Santa Maria.

The fishing gear used are poles and lines with hooks of different types with both artificial and live bait (sardines). The best fishing season is from April to June, when one fishing boat in one trip of from one to two days usually catches around 7,000 tunas. During the other months of the year the boat catches an average of 2,000 fishes per trip of from three to five days.

Table 3 shows the number of fish caught, together with weight in kilograms, by all the Sea Food fishing boats by months.

TABLE 3.—*Monthly catch of the boats of the Sea Foods Corporation.*

Month and year.	Yellowfin.		Skipjack.	
	No.	*Kg.*	*No.*	*Kg.*
1937				
August	3,144	10,109	10,118	33,179
September	6,544	20,264	19,673	52,981
October	5,118	18,329	15,258	52,393
November	1,744	3,939	7,147	26,209
December	1,988	6,391	14,559	47,070
1938				
January	1,976	8,244	15,290	52,732
February	2,501	10,057	22,842	75,870
March	3,366	14,667	12,758	45,224
April	2,937	14,660	50,608	165,069
May	9,250	34,392	62,715	179,348
June	4,930	18,011	45,747	122,661
July	5,367	19,252	23,640	62,576
August	5,037	23,654	22,976	68,957
September	6,478	23,961	16,337	52,521
October	6,350	20,798	21,957	66,035
November	9,493	38,284	19,990	68,651
December	7,326	26,443	26,338	96,861

FISHERY RESOURCES

The principal fishery product of Zamboanga Province is fish of different varieties. Most of the larger fishes are sold fresh in the markets; others are sold to the different steamers and passenger boats that call at the Port of Zamboanga. S. S. "Mayon" alone buys no less than 500 kilograms of fish weekly. There are in addition many other passenger boats which buy fresh fish at this port. In all towns and principal barrios various varieties of fresh fish are sold in the market. There was not a single market that I have visited where fresh fish were not sold. In the markets of Isabela, Cabobo, and Maluso of Basilan

TABLE 4.—*Commercial species of fishes and minor sea products caught in Zamboanga waters.*

Local name.	English name.	Scientific name.
Agoot (lagonot or lepe)	Spotted pomadasid	*Pomadasys hasta.*
Alakaak (tapoa)	Croaker	*Johnius aneus.*
Aligasin (lizas)	Mullet	*Mugil labiosus.* *Mugil dussumieri.*
Aranan, patakla (gaggok) or (cague).	Sea catfish	*Arius thalassinus.*
Asogon (rompecandado)	Barracuda	*Sphyræna jello.*
Ayuñgin (bebaan)	Theraponid	*Therapon plumbeus.*
Asohos (usus)	Whiting	*Sillago sihama.*
Apahap (matakating)	Sea bass	*Lates calcarifer.*
Babansi (bigaong)	Theraponid	*Pelates quadrilineatus.*
Bagaong (langaat)	----do	*Therapon jarbua.*
Baga baga (tiniktinik)	Soldier fish	*Myripristis melancstictus.*
Bitilla (sampok)	Porgy	*Lethrinus opercularis.*
Bakokong moro (laondon bantok).	Fresh-water porgy	*Sparus berda.*
Bebang (isda kabakaba)	Butterfly fish	*Chætodon auriga.* *Chætodon bennetti.* *Chætodon vagabundus.*
Bia (kapalo)	True goby	*Glossogobius giurus.*
Bañgos (banlus)	Milk fish	*Chanos chanos.*
Banbangin (tabong)	Snapper	*Lutjanus fulvus.*
Batalay (balo, tamlawang)	Garfish	*Tylosurus strongylurus.*
Batanpay	Parrot fish	*Leptoscarus* sp.
Bidbid (sampangaray)	Ten pounder	*Elops hawaiensis.*
Binakoko	Dolphin	*Coryphæna hippurus.*
Bokong (tusog)	Slipper (goby)	*Ophiocara procephala.*
Buan-buan (bulanbulan) (abulong).	Tarpon	*Megalops cyprinoides.*
Bokong (tusog, kapalo)	Slipper (goby)	*Ophiocara aporos.*
Bitilla (bahaba)	Snapper	*Lutjanus fulviflamma.*
Buging (pellangan or obud-obud).	Halfbeak	*Hemiramphus far.*
Bolador (Isdang lawin, sardinia or benke).	Flying fish	*Cypselurus oligolepis.* *Cypselurus brevis.*
Banak, talilong (balanak or lizas).	Mullet	*Mugil vaigiensis.*
Bongoan (gaggok)	Sea catfish	*Arius leiotetocephalus.*
Cabasi (tatik)	Gizzard shad	*Anodontostoma chacunda.* *Nematalosa nasus.*
Caballas or linachay (anduhao)	Mackerel	*Rastrelliger chrysozonus.*
Cotot	Porgy	*Lethrinus reticulatus.*
Dahong gabi (buna)	Leaf fish	*Platax orbicularis.*
Dahonan (kiampao)	Sting ray	*Dasyatis kuhlii.*
Dolesan (tambangao)	Snapper	*Lutjanus decussatus.*
Dalagang bukid (sulig)	Cæsio	*Cæsio cuning.* *Cæsio xanthonotus.*
Dumpilas (tigi)	Anchovy	*Scutengraulis hamiltonii.* *Thrissina baelama.*
Dapang bilog (kulampira)	Brill	*Pseudorhombus arsius.*
Dapang haba (kulampira tabaco)	Sole	*Cynoglossus puncticeps.*
Duhay (sampirot)	Pomfret	*Stromateus niger.*
Damis, pampano (ampahan)	Jack	*Hynnis momsa.*
Dalupane (betebete)	Moonfish	*Mene maculata.*
Dorado, lapis (lali)	Leatherjacket	*Scomberoides lysan.*

TABLE 4.—*Commercial species of fishes and minor sea products caught in Zamboanga waters*—Continued.

Local name.	English name.	Scientific name.
Dilis (bolinao)	Anchovy	*Stolephorus commersonii.* *Stolephorus heterolobus.*
Gele (bacalao) or langlanga.	Sergeant fish	*Rachycentron canadum.*
Garopa, kalatang (patikan).	Grouper	*Epinephelus fuscoguttatus.*
Garapeche (mangali)	Cavallas	*Caranx speciosus.*
Galongong (tumarong)	Round scad	*Decapterus macrosoma.*
Lañgaray paco (gono)	Silverside	*Atherina duodecimalis.*
Hasahasa, cavalla (tulay)	Mackerel	*Rastrelliger brachysomus.*
Hito (tauti tubig)	Fresh-water catfish	*Clarias batrachus.*
Ilak (palig)	Rudder fish	*Kyphosus lembus.*
Iso (ahaan or kalumbang)	Snapper	*Lutjanus argentimaculatus.*
Kabang (manangin)	Croaker	*Sciæna dussumieri.*
Kitang (kikilo)	Spade fish	*Scatophagus argus.*
Kalapo (kubing)	Grouper	*Cromileptes altiveles.*
Kalaskasin (baggong)	Snapper	*Pristipomoides microdon.*
Kanduli (gaggok or cague)	Sea catfishes	*Arius thalassinus.*
Kalaso (leneo)	Lizard fish	*Trachinocephalus myops.*
Katchorita (subad)	Bonito	*Euthynnus yaito.*
Kambabalo (balo)	Garfish	*Ablennes hians.*
Kapalo (palo)	Slipper or goby	*Ophiocara* sp.
Kataba (sumpit or sampirot).	Archer fish	*Toxotes jaculator.*
Kandaman.	Bigeye	*Priacanthus cruentatus.*
Labahita (indangan or darong)	Surgeon fish	*Acanthurus bleekeri.*
Lapad (kandaman)	Herring	*Sardinella perforata.*
Labian (lepe bato)	Thick-lipped grunt	*Plectorhinchus pictus.*
Lamkawit (dampalangan)	Wrasse	*Thalassoma quinquevittatus.*
Langaray (ibistayom)	Cardinal fish	*Apogonichthys hyalosoma.*
Lapolapo (kuyapo)	Grouper	*Epinephelus corallicola.* *Epinephelus areolatus.*
Lapolapong ligiig (kohapo or kukkut).	Grouper	*Epinephelus merra.*
Lapolapo (budyanga)	do	*Anyperodon leucogrammicus.*
Loko	Porcupine fish	*Diodon bleekeri.*
Lumahan (cavalla)	Mackerel	*Rastrelliger chrysozonus.*
Liwalo, tinikan (puyopuyo).	Climbing perch	*Anabas testudineus.*
Matang baka (katambak or tulay).	Bageye	*Selar crumenophthalmus.*
Mayamaya (mangagat or dapak).	Snapper	*Lutjanus monostigma.* *Lutjanus johni.*
Mayang (sapisapi or calcubao)	Drepane	*Drepane punctata.*
Malakapas (bansa, babae, purok).	Mojarra (gerrid)	*Gerris abbreviatus.* *Gerris baconensis.* *Gerris filamentosus.* *Gerris macrosomus.*
Majuara (gaodgaod or mulmul)	Porgy	*Argyrops spinifer.*
Mulmul (ugus)	Parrot fish	*Scarus* sp.
Oriles (kubalkubal)	Hardtail	*Megalaspis cordyla.*
Pating (tiburon or kaitan)	Gray shark	*Scoliodon palasorrah.*
Pagi (kiampao)	Sting ray	*Dasyatis uarnak.*
Palid	Surgeon fish	*Hepatus elongatus.*
Paol (pagimanok)	Eagle ray	*Ætobatus narinari.*
Parangparang (dahon tubio)	Dorab	*Chirocentrus dorab.*
Palos (indon)	Swamp eel	*Synbranchus bengalensis.*
Piit	Cyprinid	*Barbodes quinquemaculatus.*
Pindanga (indon)	Piko eel	*Muræncsox cinereus.*
Pabuka (kasil)	Moray	*Gymnothorax pictus.*
Pellan (kopog)	Lactarid	*Lactarius lactarius.*

TABLE 4.—*Commercial species of fishes and minor sea products caught in Zamboanga waters*—Continued.

Local name.	English name.	Scientific name.
Pipicao (lapis)	Leatherjacket	*Scomberoides toloo.*
Parikit banks (kamai)	Remora	*Echeneis naucrates.*
Pugot	Trigger fish	*Balistes* sp.
Talipia (talangtalang)	Leatherjacket	*Scomberoides toloo.*
Samundo	Snapper	*Lutjanus kasmira.*
Selanga (pagisange)	Devil ray	*Mobula eregoodoo.*
Sekoy (kutambang)	Pomadasid	*Pomadasys maculatus.*
Saramullete (tangbod)	Goat fish	*Upeneoides sulphureus.*
Saramullete (timbungan)	----do	*Parupeneus luteus.*
Samaral (balawis, budlong, bawis).	Siganid	*Teuthis javus.* *Amphacanthus vermiculatus.* *Amphacanthus fuscescens.*
Sunog (kamangkamang buaya)	Flathead	*Platycephalus indicus.* *Platycephalus nematophthalmus.*
Sapsap (lawaylaway)	Slipmouth	*Equula equula.*
Salaysalay aso	Mackerel	*Caranx leptolepis.*
Salmon (ulongulong, ungong)	Runner	*Elagatis bipinnulatus.*
Sampak bakal	Snapper	*Lutjanus nematopherus.*
Spada (langing)	Scolopsis	*Scolopsis cancellatus.*
Tagisang lawin (sambukot)	Cutlass fish	*Trichiurus haumela.*
Tarakitok (mansa)	Mackerel	*Caranx malabaricus.*
Tarakitok (isda puti)	----do	*Caranx* (*Carangoides*) *gymnestethoides.*
Trakitillo (butatikan)	----do	*Caranx armatus.*
Tagan (bilas)	Sawfish	*Pristis microdon.*
Tamban (kasig)	Herring	*Dussumieria hasseltii.* *Sardinella longiceps.* *Sardinella leiogaster.* *Sardinella perforata.* *Sardinella fimbriata.* *Sardinella melanura.*
Tamban (haolhaol)	----do	*Sardinella sirm.*
Tambacol (panit or barellete)	Yellowfin	*Neothunnus macropterus.*
Talapia, lapis (lali)	Leatherjacket	*Scomberoides lysan.*
Tongtong	Nemipterids	*Nemipterus nemurus.*
Torcillo (lambana, tinduktinduk).	Barracuda	*Sphyraena obtusata.*
Tanguingui (tanigue)	Spanish mackerel	*Cybium commerson.*
Talimosak (tuong uluan)	True goby	*Oxyurichthys microlepis.*
Tuakan (bolinao)	Anchovy	*Stolephorus indicus.*
Tulingan (puyan)	Skipjack (ocean bonito)	*Katsuwonus pelamis.*
Tulingan (subad)	Bonito	*Euthynnus yaito.*
Tulingan (mangko)	Frigate mackerel	*Auxis thazard.*
Sponja	Elephant ear sponge	*Leiodermatium pfeifferæ.*
Do	Common bath sponge	*Euspongia irregularis.*
Do	Sheep's wool sponge	Undetermined.
Coral (acalbahal)	Black coral	*Antipathes abies.*
Tombongtombong (tamban buhan).	Sea anemone	Undetermined.
Balatan (bat)	Sea cucumber	*Actinopyga mauritiana.* *Microthele nobilis.* *Holothuria pardalis.* *Holothuria atra.* *Holothuria scabra.* *Holothuria fuscocinerea.* *Thelenota ananas.* *Holothuria maculata.*

TABLE 4.—*Commercial species of fishes and minor sea products caught in Zamboanga waters*—Continued.

Local name.	English name.	Scientific name.
Baling (alamang)	Small shrimp	*Palæmon* spp.
Camaron (baliscugay)	Shrimps	*Penæus* spp.
Lokon	do	*Penæus monodon.*
Ulang (banagan)	Spiny lobster	*Palinurus* sp.
Cangrejo (alimango)	Crab	*Charybdis crucifera.* *Scylla serrata.*
Cangrejo (alimasag)	Blue crab	*Neptunus pelagicus.* *Neptunus (Achelous) granulatus.*
Dawat	Crab	*Thalamita dana.* *Thalamita prymna.*
Do	do	*Thalassina anomalia.*
Kokomo (karag)	do	Do.
Alupihang dagat (common)	Sea mantis	*Squilla* spp.
Cucuracha (sambao)	Raninid crab	*Ranina dentata.*
Pusit (choca or tabula)	Squid	*Loligo* spp.
Panus (bangolon or kulabutan)	Cuttlefish	*Sepia* spp.
Borsebala (coguita)	Octopus	*Octopus* spp.
Marisco (kuhan)	Ear shell	*Haliotis* spp.
Sesi (sehi)	Marine snail	*Rostellaria cancellata.* *Bursa gyrina.* *Turricula corrugata.* *Strombus luhuanus.*
Lalong or bolalo (lagong)	Green snail, turban shell	*Turbo marmoratus.*
Trocha (laak)	Smooth top shell	*Trochus niloticus.*
Trocha (simong)	Rough top shell	*Trochus maximus.*
Trocha (babae)	Hirose shell	*Trochus noduliferus.*
Concha blanca (tipay)	Gold-lip pearl shell	*Pteria maxima.*
Concha negra (tipay)	Black-lip pearl shell	*Pteria margaritifera.*
Taclobo (kima)	Giant clam	*Tridacna gigas.*
Do	Bear's paw shell	*Hippopus maculatus.*
Capis	Window shell	*Placuna placenta.*
Oreja (kiongkiong)	Ear shell oyster	*Pteris savignyi.*
Binkong	Long fan mussel	*Pinna philippinensis.*
Do	Short fan mussel	*Pinna negra.*
Turtuga	Sea turtle	*Chelonia japonica.*
Do	Hawksbill turtle	*Eretmochelys imbricata.*
Do	Loggerhead turtle	*Caretta olivacea.*

Island large fresh fish are always on sale. Most commonly sold are the different species of tuna, bonito, Spanish mackerel, barracuda, carangoids of different species, sergeant fishes, a fish locally known as *bacalao*, snappers, groupers, and sea basses; and many other smaller kinds, like sardines, anchovies, and others. Most of these fishes are caught in fish corrals, others by hook and line, spear, salapang, fish trap (bobo and others) and by fishing nets of different types. Most fish come from the Bohelebong and Kauluan grounds. Fish are usually cheap. A good-sized tuna costs only from 20 centavos up, a bonito 10 centavos, a large-sized tanguingue and rompecandado from 80 centavos to 1.20 pesos, while a large tarakitok costs from 50 centavos up. Some fishes are sold in slices.

Different varieties of fresh fish are principally sold in the markets of Zamboanga, Lamitan, Isabela, Dipolog, and Margosatubig. In Zamboanga, which is a port city, the cost of fish is much higher than in other places. A number of dried fish products are also sold in the different towns.

Minor fishery products are also sold in the different markets, the most common being different varieties of crustaceans, like the *lokon, alimango, cucuracha, baliskugay, baling* or *alamang,* and *Squilla* or sea mantis. Among the molluscs are the squids, cuttlefishes, octopus, and different species of clams and snails. Among the echinoderms and cœlenterates, different species of holothurians, like *Holothuria pardalis, Holothuria maculata, Holothuria fuscocinerea,* and others, and different species of sea anemone, from small to large forms, are sold fresh in many markets. Turtle meat (*Chelonia japonica*) and eggs are also commonly sold in many places. In Zamboanga market alone there are times when a dozen of these large turtles are butchered at the rate of one or two a day. A kilogram of turtle meat is sold for 10 centavos, and one turtle may bring 3 to 5 pesos. Usually around 150 eggs with shells and 500 without shells are removed from the body cavity of a female turtle. The eggs with shells are sold at 1 centavo each and those without shells are sold at 2 for 1 centavo. Some turtles are caught inside fish corrals, while others are caught by Moro fishermen. Most turtles sold in the market are taken from the neighborhood of Sibago and Lanhil Islands.

Other fishery resources of the province are commercial shells of different kinds and other minor marine products, like *trepang* or dried holothurians, sharkfins, tortoise shells, *bagoong* or *guinamos, binoro,* dried fishes, dried shrimps or *hebi,* dried squids and cuttle fishes, and some edible algæ. Commercial sponge is another marine product which has potential value, as it is abundant in the waters surrounding Zamboanga Province. Waters around the Taluksañgay channel, Sacol Islands, and neighboring places were exploited for the commercial elephant ear sponge, *Leiodermatium pfeifferae,* and the sheep's wool variety by a foreign sponge concessionaire by the name of P. I. Pipinos, of the Greek Sponge Company. Since then these sponges were left untouched and the stock allowed to become rehabilitated. Shallow-water sponges of the species *Euspongia irregularis* are met with in large numbers

and can be scientifically propagated. Among the commercial shells found around Zamboanga Province are the pearl oysters of the species *Pteria maxima, Pteria margaritifera,* and *Pteria savignyi;* top shells of the species *Trochus niloticus, Trochus noduliferus;* green snails of the species *Turbo marmoratus;* and window shells of the species *Placuna placenta.* Other bivalves, like *Tridacna gigas, Hippopus maculatus,* and other related species, may have potential commercial value for ornamental purposes, for ground shells, lime, and other uses. Black corrals, of different varieties of *Antipathes abies,* are another marine product of high commercial value, formerly abundant in the waters surrounding Zamboanga Province, but because of overfishing now more or less depleted; with proper regulatory measures for the collection of this valuable product, it could be conserved. Among the commercial holothurians abundant around Zamboanga Province are *Actinopyga mauritiana, Microthele nobilis, Holothuria pardalis, Holothuria atra, Holothuria scabra, Holothuria maculata, Thelenota ananas,* and a few others. Table 4 shows the commercial species of fish caught in Zamboanga waters.

FISH PRESERVATION

Generally fishes are sold fresh. Those that are not sold and consumed fresh are usually preserved dry or iced. A small refrigeration business is undertaken by Mr. James J. Wilson in connection with his ice plant. Because of the additional expense in maintaining a cold storage plant, Mr. Wilson does not usually keep the machine running at full capacity. At times large fishes sold to Compañía Marítima boats and other vessels are stored in this ice plant until the boat arrives. A limited cold storage business is done by Mr. Antonio Bayot, of the Plaza Hotel, where the fishes supplied to the S. S. "Mayon" by Moro Biri are temporarily stored before they are taken to the boat. The Sea Foods Corporation maintains its own cold storage plant, where its tuna fishes are frozen and stored.

More cold-storage facilities are needed in the city as well as in other localities of Zamboanga Province where the fish supply is abundant. Lamitan, Dipolog, and Margosatubig are in need of cold storage facilities. The small refrigeration units at present found in the city are of great help to the fishermen and residents of Lamitan, Dipolog, and Margosatubig, as because of the absence of cold storage plants in these principal fishing

towns the fish usually spoil and go to waste, especially when the fishermen run out of salt.

DRYING

Drying fish is practiced only when absolutely necessary. In Margosatubig, Tantawan, and other places, however, fish drying is considered a part of the business of the Chinese fish dealers, who have regular drying platforms along the waterfront where fishes are dried after salting (Plate 4, fig. 1). At other places fish are occasionally dried along the beaches, where they are placed on bamboo matting laid flat on the ground or on raised temporary platforms. Tarakitok, cavallas, tamban, and bolinao are the fishes dried. The last-named is usually dried without salt during sunny days. Tamban and small cavallas are immersed in brine solution in the round from two to twelve hours and usually dried whole. Larger fishes are usually split into halves from the dorsal side and sprinkled with salt before drying.

SALTING

Salting is done in two ways: dry salting and brining. In the former the salt is sprinkled on the product to be preserved. This is done in two proportions, (*a*) 1 part salt and 2 parts fish, a mixture known as *sinabado,* where the fish ferment early and are not kept long, and (*b*) 2 parts salt and 1 part fish. In the latter the mixture takes longer to ferment and the product usually keeps longer. In brining the following proportion is used: (*a*) 50 cans [2] fish to 25 cans of sea water with 3 sacks of salt, or (*b*) 50 cans fish to 20 cans of sea water with 2 cans of salt.

In the bagoong or guinamos industry small fishes, usually sardines (lupoy) and anchovies (bolinao) are used. In Dipolog only Filipinos, mostly fishermen, are engaged in this industry. In Margosatubig, Tantawan, and other places the business is entirely in the hands of the Chinese. The cost of material and labor per 5-gallon can of guinamos in Dipolog is as follows: fish, 60 centavos; salt, 15 centavos; can, 25 centavos; labor, 11 centavos. A can of guinamos sells at from 1.40 pesos up to 1.80 pesos. Most of the product is sent to the Visayan Islands.

In Margosatubig the cost of the material is lower (fish, 40 centavos; salt, 12 centavos; can, 20 centavos; labor, 10 centavos). In this place a can of bagoong or guinamos sells for from 1 peso up to 1.20 pesos.

[2] Empty 5-gallon petroleum cans.

BINORO

Another fish product is the *binoro,* made principally in Dipolog and neighboring localities. The making of binoro is seasonal, being done from January to May, with March and May as peaks of the season. Every year the production is becoming greater, products being marketed in Dumaguete, Oriental Negros Province, in the neighboring municipalities, and in the interior towns of Zamboanga Province and neighboring provinces. Herrings of the species *Sardinella sirm,* locally known as *tamban haolhaol,* cavallas of the species *Rastrelliger chrysozonus,* locally known as *anduhao,* and other related fishes are used in making binoro. The fish is salted and left to ferment for four to ten hours. The salted fishes are then placed in layers inside a petroleum box or finely woven bamboo basket. Salt is sprinkled over each layer in the case or basket.

The cost of material and labor per case of binoro is as follows: fish, 3 pesos; salt, 50 centavos; box, 20 centavos; labor, 15 centavos. One box or case of binoro sells at from 4 pesos to 8 pesos. A basket of binoro is equivalent to about 3 cases and sells at from 14 pesos to 18 pesos.

PATIS

Patis is usually prepared from extracts or sauce of salted *lupoy* or *bolinao,* which are stored in large vats or barrels for at least a year. The sauce is then filtered and later boiled. Patis-making is not a regular industry, only a few fishermen in the guinamos industry preparing this product on a small scale and for home consumption.

SMOKING

Smoking fish is not popular, and hardly known to the fish dealers of Zamboanga. Moros, however, smoke and roast their common favorite fishes, like the tulingan and tarakitok. The fish is partly roasted and smoked and sold in every market where there are Moros. It is said that fish smoking was started by a Tagalog fisherman at Dipolog but did not prosper, due perhaps either to the fact that smoked fish has a peculiar taste or to faulty preparation. At present there are persons interested in fish smoking; to these the methods used in Manila and in neighboring places, together with the improvements made by the Division of Fisheries, are recommended.

It is believed that if a scientific method of smoking fish is introduced in Zamboanga Province the business may prosper and may help salvage fresh fish in times of abundance.

CANNING

The most up-to-date method of fish preservation in Zamboanga Province is the canning of tuna fishes by the Sea Foods Corporation (Plate 5). The tuna used by the cannery are the yellowfin (*Neothunnus macropterus*), the skipjack (*Katsuwonus pelamis*), and a few other species and varieties. These are caught by means of pole and hook and line, with both artificial and live bait. The tuna-fishing season is during April, May, and June. During this period the cannery runs at full capacity and employs over 150 women. Several men are employed to do the more strenuous manual work and in fish dressing. In addition, a few men are employed in packing and in attending the retorts and other machinery.

The maximum cannery output per day is 500 cases, each case containing 48 cans. The average daily output is from 200 to 300 cases, with 40 to 50 kilograms of fish per case. The average weight of the skipjack is 3 kilograms, so that a case of 48 tuna cans of the "light meat" requires from 13 to 17 fishes. A yellowfin has an average weight of 5 kilograms, so that a case of 48 cans of "white meat" requires from 8 to 10 fishes. The monthly shipment of finished product to the United States is from 3,000 to 4,000 cases, with an approximate value of from 27,000 pesos to 36,000 pesos.

Canning method.—After the fish are dressed and cleaned by the gutters they are arranged dorsal side up in iron crates and conveyed to the cooker by a conveyor. The cannery has 3 cookers, accommodating about 1,188 fishes, and cooking is done by steam generated by a boiler. The cooking period takes 2 hours under 2-pound pressure and at a temperature of 210° F. After cooking the fish are allowed to cool and harden overnight and then split into longitudinal halves, the vertebral columns removed, and each half in turn again split into quarters along the lateral line. The four pieces produced from one fish are arranged in piles on the dressing table and carried to another table where women peel off the skin and remove the blood and other undesirable parts. The cleaned pieces are laid on wooden trays and cut into sections in the wooden cutting apparatus with the use of a large sharp knife. The sections, which are slightly shorter than the height of the cans, are taken to the filling table where women place them by hand inside the cans (Plate 6). The cans are first brought

by a conveyor to the salt and oil table where women add measured amounts of refined salt and cotton seed oil. They are then filled with four sections of meat and passed to the weight checkers who weigh each can with a small balance. The filled cans are then conveyed to the other end of the table where more oil is added to fill the space. Then the tops are placed on the cans, and they are conveyed to the sealing machines. (The company has a double seaming machine which seals at the rate of 60 cans per minute, and a small sanitary vacuum seamer which seals at the rate of 10 to 15 cans per minute). From the seamer the sealed cans are carried mechanically to the washing tank where they are washed with hot lye solution to remove grease and oil. From the washing tanks they are arranged on carriers and then taken to the horizontal retort for processing or sterilization. Formerly, after this process, they were retorted for at least 2 hours under 7-pound pressure at a temperature of 240° to 250° F.; at present the time is greatly shortened and the amount of pressure almost double under the same temperature.

From the retort the cans are conveyed to a large concrete tank of cool water where they are immersed for cooling. A more recent cooling device is made inside the retort where a cool water sprayer does the cooling without the sterilized canned products being immersed into the concrete tank of cool water. Then each can is tested and checked by a leak tester. After the leaking cans are condemned, the tested cans are taken to the cleaning department where they are cleansed and polished with sawdust and other cleansing materials, labeled and crated. The Sea Foods cannery prepared two kinds of pack, the "fancy" and the "flakes." The fancy pack, described above, consists of solid meat sections, while the flakes consist of slightly salted small pieces of meat and some scraps from the clean lobes, mashed up before oil is placed in the can. There are two kinds of fancy product, the "white meat" and the "light meat." The former is made from the yellowfin tuna and the latter from the skipjack. Two other new products are prepared, the seasoned tuna flakes and those with some kind of sauce and flavoring materials used instead of the oil. These latter products are intended for the local market.

Table 5 shows the monthly production of the Sea Foods Cannery at Zamboanga.

TABLE 5.—*Monthly production of the Sea Foods Cannery at Zamboanga.*

Month and year.	White meat.		Light meat.		Total.	
	Cases.	Cans.	Cases.	Cans.	Cases.	Cans.
1937						
August	315	18	960	46	1,276	16
September	378	44	1,024	42	1,403	38
October	571	26	1,352	33	1,924	11
November	114	20	1,083	19	1,197	39
December	158	10	862	34	1,020	44
1938						
January	386	20	1,772	35	2,159	7
February	320	20	2,246	38	2,567	10
March	497	45	1,382	10	1,880	7
April	248	31	2,772	22	3,021	5
May	1,015	31	3,873	28	4,889	11
June	704	26	3,642	33	4,347	11
July	525	33	1,171	40	1,697	25
August	717	25	2,137	14	2,854	39
September	566	43	1,155	9	1,722	4
October	712	9	1,299	23	2,011	32
November	909	1	2,042	9	2,951	10
December	1,001	41	2,590	37	3,592	30

SUMMARY AND RECOMMENDATIONS

1. The principal shallow fishing grounds of Zamboanga are Margosatubig, Tantawan, Takut Tangug Bay, Dipolog, and Sindangan Bay, and practically the entire coast line surrounding the Zamboanga Peninsula.

2. For the conservation of the fishery of some depleted fishing grounds, like that of the Igat Bay, fishing with light in connection with the pukot should be regulated.

3. More sanitary supervision over the preparation of guinamos or bagoong and the drying of fish is necessary to improve the quality of the products turned out.

4. Refrigeration should be resorted to in the preservation of fresh fish in the important fishing centers.

5. Deep-sea or off-shore fishing must be exploited. Filipino capital should be induced to invest in the fishing industry, and fishing boats of over 20 tons should be used.

6. Primitive fishing gear must gradually be replaced with modern types.

7. Illegal fishing methods with the use of explosive and poisonous substances must be checked.

8. Other fishery products besides fish must also be given proper attention.

9. Canning of other fishes, like sardines, cavallas, and the like, must be developed as a means of proper fish utilization.

10. Other methods of fish preservation, like smoking, patis-making, and the like, must be encouraged.

11. The bañgos fishpond of the Malabon type must be encouraged.

12. A tuna cannery similar to the Sea Foods Corporation, under a semigovernment organization like the National Development Company, must be encouraged, to exploit the extensive tuna-fishing grounds around Zamboanga Province.

ILLUSTRATIONS

PLATE 1

FIG. 1. Bobo, a typical fish trap, used around Manicaan.
2. Banata, a small fish corral usually constructed at the gate of fishpond at Ramos fishpond, Mampang.
3. A portion of a fishpond showing two wooden gates at Arquiza's fishpond, Talontalon.

PLATE 2

FIG. 1. A cast net, laya, being dried at Bohelebong.
2. A sakag used around Talontalon.
3. Bamboo crab traps, called nasa, and a dip net, sihud, used for catching fish from the banata.

PLATE 3

FIG. 1. A portion of a fishpond showing a gate and banata at Evangelista's fishpond, Salinas.
2. A portion of the Arquiza fishpond, showing a rede, a small net, used for catching fish from one of the smaller compartments.
3. A bunsod, showing the bunuan and the small hut where fishermen stay day and night.

PLATE 4

FIG. 1. A *batalan* fish-drying platform of one of the Chinese fish dealers at Margosatubig.
2. Some of the game fishes sold at the Isabela market. They are baracuda, Spanish mackerel, and talakitok.
3. A portion of the Isabela market, showing tanguingue fish or Spanish mackerel (*Cybium commerson*), a common fish sold at the rate of from 80 centavos to 1.20 pesos each.

PLATE 5

A view of the Sea Foods Cannery at Zamboanga.

PLATE 6

Packing tuna fish at the Sea Foods Cannery.

TEXT FIGURES

FIG. 1. Bunsod fish corral. *a*, bunuan; *b*, sagaran; *c*, kaluagan; *d*, pikpik; *e*, pamansan.
2. Variations of the bunsod. *a*, bunuan; *b*, sagaran; *c*, kaluagan; *d*, hut.
3. Paugmad fish corral. *a*, tulis; *b*, bamboo platform; *c*, platform consisting of a single piece of bamboo for dragging the sigin; *d*, hut.

FIG. 4. Pahubas fish corral. *a*, bunuan; *b*, sagaran; *c*, pikpik; *d*, tulis.

5. Balerong fish corral. *a*, direction of flow at low tide; *b*, direction of flow at high tide.

6. Panera, river fish corral. *a*, river; *b*, creek; *c*, swamp; *d*, flow of water during low tide; *e*, wing of the panera or usually a bank of the river.

7. Ampas fish corral. *a*, bobo; *b*, lugo; *c*, coarsely woven bamboo matting.

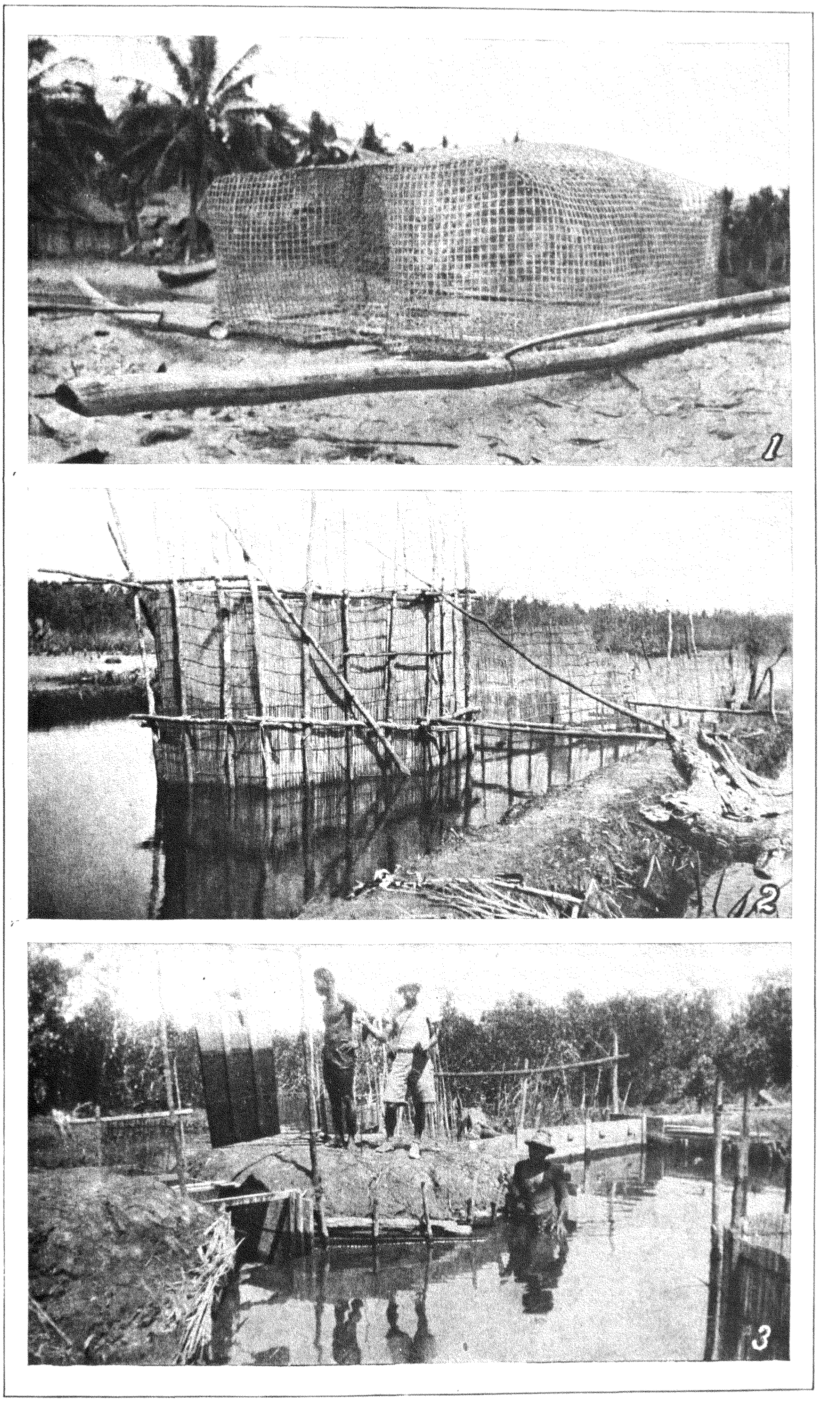
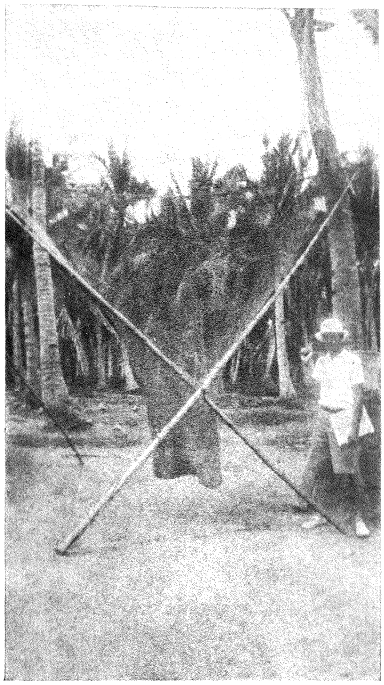


PLATE 1.

1



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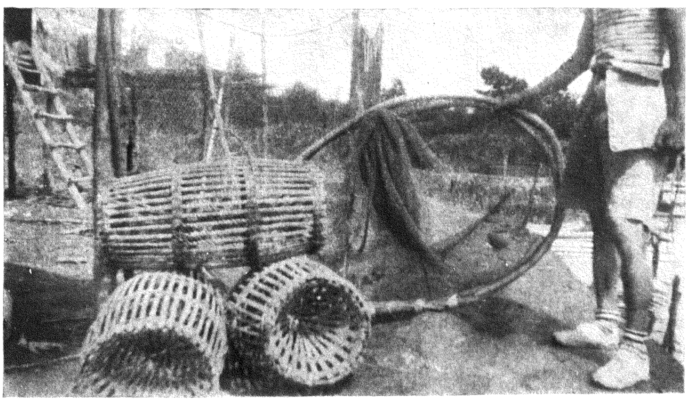

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PLATE 2.

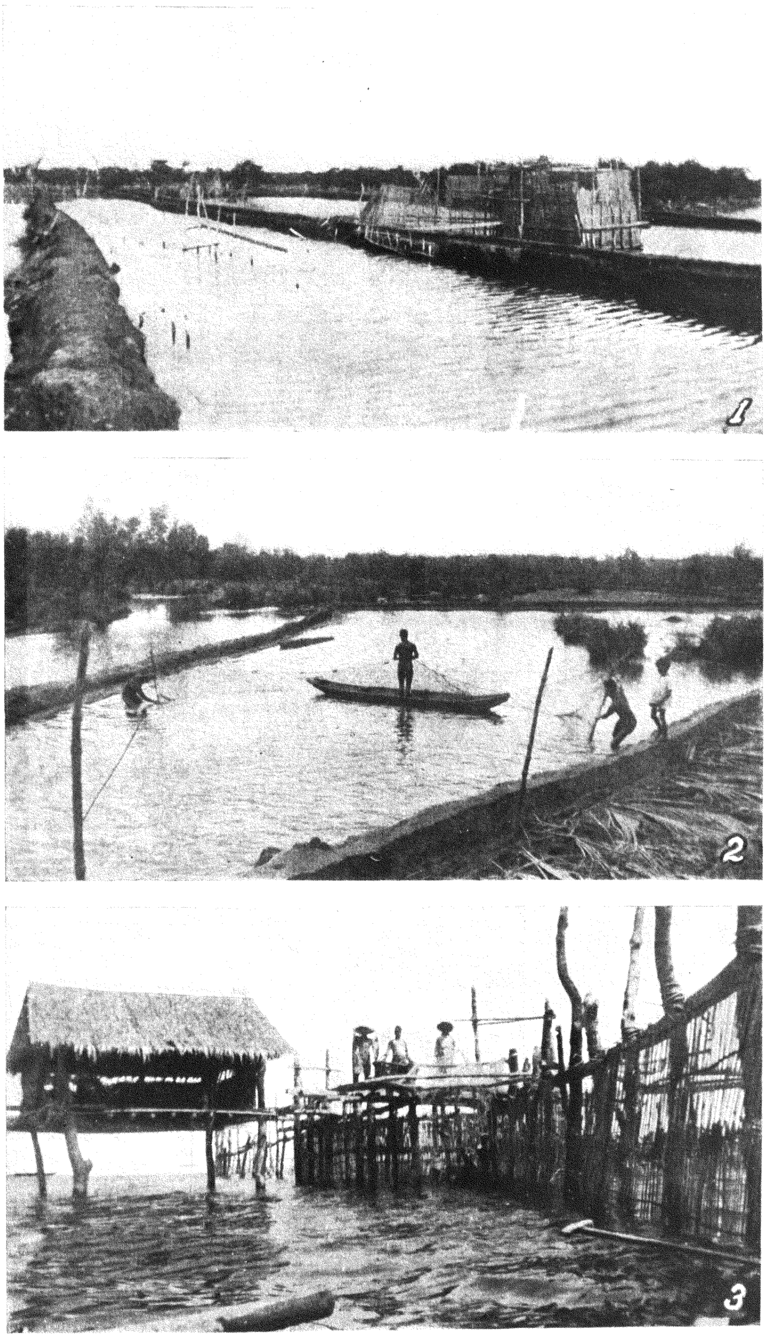

PLATE 3.

PLATE 4.

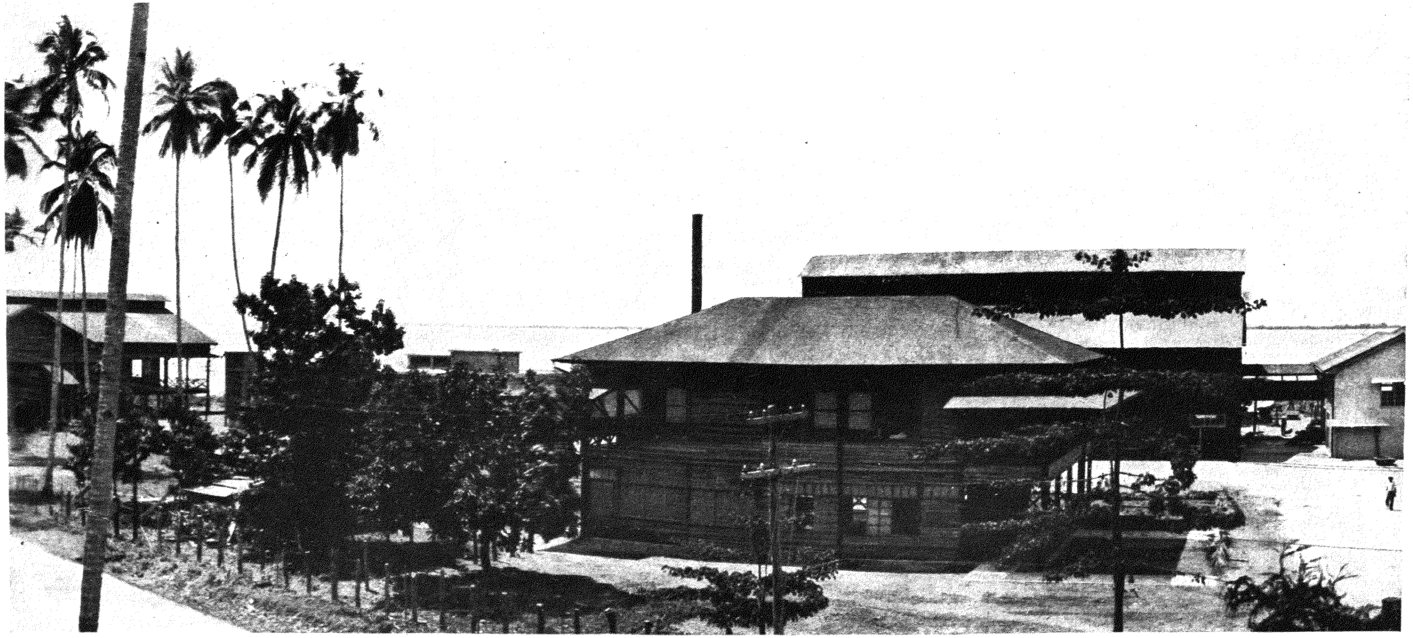

PLATE 5.

PLATE 6.

EPIBLASTUS IN THE PHILIPPINES

By L. O. WILLIAMS

Of the Botanical Museum, Harvard University, Cambridge, Massachusetts

About twenty species of the genus *Epiblastus* have been described, extending, in range, from Samoa to Celebes, with about fifteen of the described species originating in New Guinea. The species described below is the first species of the genus known to occur in the Philippine Islands. In Merrill's Enumeration of Philippine Flowering Plants the genus should be added to the Orchidaceæ, between *Dilochia* and *Ceratostylis*.[1]

EPIBLASTUS MERRILLII Williams sp. nov.

Herba epiphytica. Pseudobulbi cylindracei, unifoliati. Folia lineari-lanceolata, acuta vel plusminusve obtusa, apice sine lobis, coriacea. Flores fasciculati ex apice pseudobulbi terminalis. Sepalum dorsale late lanceolatum, acutum vel acuminatum, leviter naviculare, obscure quinquenervium. Sepala lateralia late lanceolata, basi obliqua. Petala lanceolata, acuminata. Labellum rhomboideum, lamina obovata sed cum apice acuminato. Columna et anthera generis.

An epiphytic herb up to about 4 dm long. Roots filiform, pubescent, small. Pseudobulbs cylindrical or probably somewhat flattened, especially terminal portion, stem continuing from middle of each pseudobulb, pseudobulbs 1-leaved, apparently only the terminal (annual) one bearing the few-flowered inflorescence. Usually several chartaceous sheaths at base of pseudobulbs. Leaves linear-lanceolate, acute or somewhat obtuse, not lobed at apex, coriaceous, 15 to 35 cm long, 2 to 3 cm broad. Flowers about ten, fasciculated from apex of terminal pseudobulb, on slender peduncles. Peduncles slender, terete, up to about 10 cm long. Bracts small, peltate at base, acuminate. Dorsal sepal broadly lanceolate, acute or acuminate, slightly naviculate, obscurely 5-nerved, about 8 mm long and 3 mm broad. Lateral sepals broadly lanceolate, acuminate, strongly oblique at base, 10 to 12 mm long, about 4 mm broad. Petals lanceolate,

[1] Merrill, Enumeration of Philippine Flowering Plants 1 (1925) 317.

acuminate, 3-nerved, about 7 mm long and 2 mm broad. Lip rhomboid in outline, about 9 mm long and 4 mm broad, blade obovate but with a lanceolate apex which is nearly as long as the blade, disc with a callus plate. Mentum prominent, about 2 mm long. Column and anther of the genus.

MINDANAO, Zamboanga Province, Sax River Mountains, *Merrill 8155*. Type in Herb. Ames; isotype in Philippine National Herbarium, Bureau of Science, Manila, November 28, 1911, epiphyte, altitude about 1,000 meters: Bukidnon Province, Mount Candoon, *Bur. Sci. 38911a Ramos & Edaño,* June and July, 1920, on tree, mossy forest slopes: Cotabato Province, Mount Matutum, *Bur. Sci. 85450 Ramos & Edaño*, April 10, 1923, flowers red, altitude about 2,350 meters.

Epiblastus Merrillii seems to be distinct from all other species of the genus in the structure of the flowers and of the pseudobulbs.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

American Medical Association Interns' Manual. Edited by the Council of Medical Education and Hospitals and the Council on Pharmacy and Chemistry of the American Medical Association. Chicago, American Medical Association, 1938. 230 pp. Price, 60 cents.

This highly practical manual is an attempt to provide a sound basis for the training of interns who wish to make the best of practical knowledge in medical training. As successor to the handbook, "Hospital Practice for Interns," the manual differs from its forerunner throughout its contents, but aims at the same purpose of providing the intern with helpful suggestions as to his conduct in the performance of his services to both the hospital and the public, basic data of reference, particularly to the laboratory and emergency cases, and exceedingly useful information as to drugs and dietary therapeutics of established and proved value. In short, the mission of this book is the installation and preservation of a sound and wholesome relationship between trainers and trainees, the correction of evils most likely to influence interns and young physicians, and the encouragement of these to continue their delicate task.

The opening pages give general information regarding internship and residence. A discussion of the technical considerations of the relationship of an intern and the hospital administration follows. In the practical application of knowledge, most interesting to interns are first-aid treatment and management of emergency cases, laboratory procedures of examination, the useful drugs as arranged therapeutically, the aid in food prescriptions in normal and special diets with illustrative tables, physical therapeutics, and the legal aspects of internship.

The manual brings forth the needs of interns that are always foremost. It is an excellent companion of the hospital rule book and formulary—S. A. E.

Philippine Pagans. The Autobiographies of Three Ifugaos. By R. F. Barton. London, George Routledge & Sons, Ltd., 1938. 271 pp., illus., front. Price, 15s.

This book is the outcome of a field trip made by Doctor Barton to Ifugaoland. The author makes it clear in his preface that the biographies are "presented only as primitive documents" which he hopes will be useful to others as well as to himself in further studies.

The book opens with a chapter on "How the Ifugaos live" setting forth their particular region, sources of livelihood, skill and industry, organizations, religion, customs, and other characteristics of the tribe.

The following three long chapters are autobiographies of three typical individuals written "as nearly in the way they were related" to the author. The revelations center on the art of love, courtship, and marriage, which are very peculiar to these mountaineers. The biographies are exhaustive in their expositions on the "promiscuity and irresponsibility (from our point or view) of sex relations . . . and the minimal selectiveness on the part of both sexes in initiating these relations." On the other hand the sanctity of marriage among the Ifugao is a very striking contrast to such promiscuity and irresponsibility. The conditions under which divorce may be granted an estranged husband or wife without serious consequences are set forth in the book. The gentleness of the Ifugao in peace and his fierceness when provoked, especially when family pride is at stake, are very well brought out in the narrations.

Doctor Barton incidentally describes the highly developed coöperative labor system among these pagans. Their fairness in the give-and-take system in rational economic life is remarkable. He has recorded and made explanations of many rituals, beliefs, customs, and omens of the Ifugaos.

The book is interesting, instructive, and readable. Its circulation, however, should be limited to "mature readers and students of anthropological and social sciences."—Q. A. E.

Men, Medicine and Food in the U. S. S. R. By Fe Le Gros Clark and L. Noel Brinton. London, Lawrence and Wishart, 1936. 173 pp., illus. Price, 5s.

This book is a brief description of the rise and growth of Soviet health and food services. The writers in a space of 167 pages have tried to give a clear picture of how Soviet Russia has been approaching one of the biggest problems of

today—the food and health of the people. According to the authors, three points must be kept in mind in interpreting what is happening there. First, that the country is still in the process of growth; second, that the conditions as they are found should be judged in relation to the conditions as they were in 1917; and third, that there is in that country a new civilization unlike any with which we are familiar. In this book they pictured how the people are attacking their problem of foods and medicine in a way peculiar to themselves.

In the concluding chapter the authors stated:

> Whatever may be said of the Soviet economic system, it has at last brought to birth the science of preventive medicine. Pathologists have in late years been veering slowly to the opinion that, in combating disease, one must pay at least as much attention to the soil, the human body as to the micro-organisms that may invade it. To contemplate delicate and continuous adjustment between the body and its environment of sunlight, air, moisture, warmth and food. Individual health is an attribute not of man but to the whole community and of that community in relation to nature. Positive health can only be assured in a community where every other and where all barriers have been demolished that might inhibit the flow of air and sunlight, food and water supplies.

This book gives an answer to the very interesting question "How can we marry agriculture and health?" It should be read by all health administrators and those who are interested in the problem of nutrition and malnutrition in their own countries. The book is an interesting contribution to the study of the relation between the food and health of the people, which is the dominant problem in all countries today.—I. C.

Your Aquarium; A Guide to Cold Fresh-Water Aquarium-keeping. By J. A. Crabbe. London, The Bazaar, Exchange & Mart, Ltd., n. d. 66 pp. Price, 1s/6d.

In this booklet the author has aptly put together very practical directions and discussions on making and keeping an aquarium. He has grouped his explanations into six well-defined chapters under each of which are well-planned and well-arranged interesting topics.

The book begins with the correct choice of the suitable shape and size of the aquarium under different conditions, and where and how to keep the tank for absolute cleanliness and freshness in order to give the fish the most wholesome surroundings. This is followed by an elementary description of various aquarium fishes, especially the different varieties of goldfish. Mention is made of the fishes that can be reared together and those that are traditional enemies. The third

and fourth chapters treat of beneficial and harmful water-creatures as well as the different water plants and their adaptability and culture in the aquarium. The last chapter deals exclusively with the care of the goldfish throughout its life. The booklet closes with a very good list of references on aquarium keeping and aquatics plants.

The booklet is brief but complete for practical purposes. The directions, explanations, and descriptions are written in simple language. To the amateur aquarists and to those who are fond of observing living things this booklet should prove very useful.—Q. A. E.

Southern Forestry. By Charles N. Elliott and M. D. Mobley. Atlanta, Georgia, Turner E. Smith & Company, 1938. 494 pp., front., illus. Price, $1.60.

The book is intended primarily for the people in the southern United States, where about forty-seven per cent of the total forest area of the country is located. The authors point out the important rôle forestry plays in the economic and social life of the Southerners. But while the book deals mostly with the forest conditions of the region and its various problems, the treatment is so broad and so well presented that the book will be found useful in general forestry anywhere. The authors are well-known pioneers in forestry and popular forestry education, having more than a decade of experience in scientific and practical forestry. This accounts for the appealing and interesting discussions which can easily be followed by the layman. The authors believe that forestry should have a place not only in the curricula of higher educational institutions but also in the curriculum of every school system, both rural and urban.

The book contains twenty-four chapters dealing with all phases of forestry. It is adequately illustrated with pictures and reinforced with valuable data and charts. A novel feature of the book is the list of suggestions and references given at the end of each chapter, designed to simplify the solution of various forestry problems. The authors discuss useful and illuminating questions in each chapter, including the simplest and most intricate problems, and cite the most modern and practical methods of approach for the successful practice of forestry. The book will be highly appreciated by those who are especially interested in forest management, forest products, and reforestation work. With the context so rich in informa-

tion on forestry, the book is valuable to all who live in the forest sections of the country. It is an excellent reference for those who are interested in the practice of forestry as well as for teachers in vocational education, particularly in agriculture.—E. F. R.

International Bibliography of Agricultural Economics, Vol. 1, No. 1. By the International Institute of Agriculture, Rome. October, 1938. 137 pp. Published quarterly. Price, $1.60 per annum.

This bibliography is a continuation of "Berichte über Landwirtschaft" until recently published by Paul Parey, of Berlin. It indexes in a very general way all publications "dealing on the economic and social aspects of agriculture in the widest sense of the words," that are received from all countries by the Institute. The staff members of the Institute's library, who are in charge of the compilation, follow a special scheme devised by the Institute and printed in outline form after the introduction.

The citations listed in this first issue of the series are grouped under fourteen inclusive subjects. The subheadings do not follow any definite arrangement, although the references are grouped under each country, as far as possible, and listed alphabetically by author. The items are serially numbered.

The compilers announce in the introduction the inclusion at the end of each volume of an author index, which undoubtedly will facilitate its use. To enhance further the usefulness of this bibliography, a good subject index should also be appended.
—Q. A. E.

Index to the Literature on Spectrochemical Analysis 1920–1937. By William F. Meggers and Bourdon F. Scribner. Philadelphia, American Society for Testing Materials, 1939. 59 pp. Price, $1.

This publication is the first attempt at putting together the widely scattered literature on spectrochemical analysis. Unlike two of its more important forerunners, "Bibliography of literature on spectrum analysis," compiled in 1935 by D. M. Smith, which included 195 papers on metallurgy, and "Spectrochemical abstracts, 1933–1937," with its 228 papers, compiled by F. Twyman, this index is general and comprehensive in scope, listing over 900 references published from 1920 to 1937, inclusive.

The introductory part gives a brief but inclusive account of the development of the science of spectroscopy as applied to chemistry. The index proper is divided into two sections;

namely, literature citations and detailed index. The citations, which are given in English except for a few books in foreign languages, are in chronological order. The items under each year are arranged alphabetically by the author. Each reference has a serial number which serves to identify it and guide the user to the corresponding entry in the citations.

To those engaged in spectrochemical research and related work this pamphlet is very important, if not indispensable.

—Q. A. E.

Cause and Prevention of Disease. By William Harvey Perkins. Philadelphia, Lea & Febiger, 1938. 713 pp. Price, $7.50.

The main object of this book is to give the reader a systematic survey of the principal causes and origins of the disease and to acquaint him with all the essential facts about the mode of transmission and prevention. The materials used in this investigation consist of clinical data gathered from authoritative sources and discussed thoroughly in a detailed outline form.

The first chapter deals primarily with a new system of classifying diseases into six general groups, based upon the principal etiologic factors. Every group gives a brief description of the clinical aspect of the disease in relation to health. The method of classifying is simple and accurate and gives the reader an opportunity to have a clear understanding of the subject.

The important features of this book include a description of the relation of heredity to health, and the mechanisms involved by which the inheritance factor can be transmitted to the individual and the diseases that accompany it. It also offers a comprehensive study of the nutrition of men in health and disease, including an analysis of the chemical and physiological properties of the different food elements, and the metabolic changes that take place within the human body. It shows the need of protective measures against all nutritive defects. Another feature of this book is that part which deals with various processes of poisoning and intoxication. The toxic properties of the different poisonous substances, their pathologic effect upon the human body, and the prophylactic measures for prevention are well presented. The book also presents a brief serologic study of the human body and a bacteriological survey of the different pathogenic bacteria, fungi, and parasites. It describes the rôle which these microörganisms play in the epidemiology of infectious

diseases. The last chapter deals with a comprehensive study of the influence of the psychic factors on the physiologic activities of the human body. It discusses the etiology of various types of nervous and mental disorders and their effect upon the intellectual faculties of man.

The book is a good guide not only to the medical man but also to those who are interested in acquiring adequate knowledge on preventive medicine.—P. J. A.

Resisting Drought. By Reenen J. Van Reenen. Pretoria, The Government printer, 1935. 221 pp., frontis., illus.

This handbook is a rewritten form of the Report of the Drought Investigation Commission, Union of South Africa. It gives a discussion of the conditions obtaining in the Union. Although a few chapters are not applicable to the Philippines, the underlying principles are food for thought for every Philippine agriculturist and farmer.

The chapters, twenty-one of them, are concise, but seem to include all the vital information on each topic discussed. For example, Chapter I consists of a few short paragraphs. The author gives a general but picturesque view of drought, its immediate and remote causes, and its effects which extend even to the clergyman who at first may be thought beyond its influence. He defines water chemically and discusses the rôle it plays in all forms of life.

The author discusses farm practices in the Union of South Africa that tend to destroy the vegetation which is helpful in the conservation of the soil. Then he advances measures to remedy the devastating effects of such practices. Soil erosion and its causes and prevention are briefly discussed.

The means and methods of taking advantage of the infrequent and uncertain rains, the preservation of feeds in silos, construction of railways, cold storage of stock products, economic grazing, and catching of the run-off by constructing reservoirs are some of the essential factors recommended for successful farming.

The value of this book is increased by the inclusion, in the form of appendices, of the circulars on the problem encountered by the Drought Commission, the summary of the original report, and other basic information. It is a useful guide for farmers, especially in places where the water supply is a problem. It is illustrated. Realizing the value of the information the handbook gives, the author painstakingly made the text understandable even to the layman.—H. S. S.

Floral Morphology. A New Outlook with Special Reference to the Interpretation of the Gynæceum. By E. R. Saunders. Volume 2. Cambridge, W. Heffer & sons, Ltd., 1939. 609 pp., illus. Index to vol. 1. Price, 10s/6d net.

In genesis and scope this volume is similar to the first volume, published in April, 1937. The author believes that the formation of whorls of midrib bundles and their correspondence with the whorls of floral members is a fundamental feature of floral construction, and the fact that these midrib bundles originate from definite radii provides a means of determining the number in a whorl. Whether or not, or at what level these bundles branch, has no significance in regard to the number of the members in a whorl. Only their morphological form is thereby revealed. On this principle families are grouped, irrespective of their systematic position, though so far as was compatible with the author's plan, those more closely related were grouped together in the sections. The types were carefully selected, so as to vividly illustrate his principles, and at the same time likely to be in general more or less easily secured. This volume as a whole is illuminating and brings forth a new and fresh avenue for the proper approach to the grouping of our angiosperms, and may point to the possible solutions of our "puzzles" or "knots" in the family tree. The separate appendix, which gives an epitomized historical survey of the challenge made by numerous botanists between 1823 and 1923 to the traditional view of the structural nature of the gynæceum, certainly makes this volume the more indispensable to students of systematic botany.—J. B. J.

Malnutrition, the Medical Octopus. By John Preston Sutherland. Boston, Meador Publishing Company, 1937. 368 pp. Price, $3.

This book was written, according to the author, to point out certain errors in human diet and nutrition, from prenatal days to advanced stages of human life. In it the author tries to emphasize the fact that a large percentage of human ills may be the result of a faulty and unbalanced diet. He also calls attention to the preventive possibilities of a natural and rational diet.

The book is divided into twenty-two chapters, the most interesting being the chapters entitled "The Prevention of Cancer; A Deficiency Disease and Malnutrition, the Medical Octopus." It is a departure from the usual presentation of

the subject as the author himself admits when he says in his preface: "In the following pages are set forth views which differ considerably from the commonly accepted ideas and practices concerning diet . . ."

Although many will disagree with the author in his views regarding the nutritive value of milk, his discussion about milk in Chapter III is worthwhile reading. The book should be read by all those who are interested in the subject of nutrition, on which it contains much valuable information. The medical practitioner should also read this book, especially the chapter dealing with malnutrition, where he can find many valuable pointers regarding nutrition.—I. C.

The Camper's Handbook. By Dillon Wallace. Illustrations by Edwin R. Cornwin. New York, Fleming H. Revell Company, 1936. 289 pp., illus. Price, $2.

The book is a very handy guide for every camper, being clearly and simply worded and vividly and adequately illustrated. The book contains twenty-five chapters. In the first chapter the author gives a brief account of the history of camping in the United States. In the next eight chapters he defines and discusses various types of camping, and lists, describes, and illustrates the various materials and equipment which each type needs. The next four chapters deal with equipment for the individual camper. One chapter is devoted to a detailed discussion on the economical ways of provisioning the camp. Another eight chapters treat of efficient and economical camping stoves and pack bags, technique of building camp-fires and open-fire cooking places, methods and materials for home-made tents and how to waterproof them, fabrics and leathers, and methods of preparing game and fish for immediate or future use. In two more chapters the protection and treatment of the camper from bites or injuries inflicted by insects, serpents, poisonous plants, and other pests are fully discussed. The book closes with a discussion on the preparation of meals in the camp, including recipes adequate for the go-light cruiser and hunter. Although intended for the American camper, the author's treatment of the principles underlying successful camping is so thorough that the book should be very useful to any camper outside the United States. The book should also be very valuable to anyone who goes outdoors to get a feel of Nature.—S. A. M.

Modern Theories of Organic Chemistry. By H. B. Watson. Oxford, 1937. 218 pp. Price, $4.50.

This book explains the application of electronic theory to the reactions of organic compounds.

The first chapter gives a brief review of the important theories of chemical combination from the time of Dalton and Lavoisier to J. J. Thomson, G. N. Lewis, and other recent contributors.

The second chapter gives an excellent account of the new physical methods of investigating organic compounds. These methods are X-ray, visible and infra-red spectra, and dipole moments.

In the following chapters the general reactions involving addition, substitution, tautomerism, molecular rearrangements, free radicals, and stereochemistry are explained in a very concise and simple manner in terms of the electronic theory.

The book is very interesting and instructive and, no doubt, will be greatly appreciated by those who are engaged in other lines and have not kept abreast in modern theories of organic chemistry.—A. P. W.

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““# THE PHILIPPINE JOURNAL OF SCIENCE

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AN OUTBREAK OF HÆMORRHAGIC SEPTICÆMIA IN INDIAN BUFFALOES

By TEODULO TOPACIO[1]

Of the Veterinary Research Division, Bureau of Animal Industry, Manila

TWO PLATES

In 1912 Mohler and Eichhorn reported the use of septicæmia vaccine in the control of an outbreak of hæmorrhagic septicæmia among the buffaloes in Yellowstone Park. From all indications the epizoötic occurred some time in 1911.

In the Philippines all outbreaks of septicæmia that have come to official notice so far occurred among cattle and carabaos. Since the introduction of Indian buffaloes into this country in (1903),(1) as far as our records are concerned, the outbreak reported in this paper is the first of its kind studied in the field and diagnosed in the laboratory.

June 14, 1938, a letter was received by Director Gregorio San Agustin, of the Bureau of Animal Industry, from Dr. Pedro de Guia, Superintendent of the Bongabong Stock Farm, Nueva Ecija, reporting the sudden death of a 4-year grade Indian buffalo. This animal was reported missing on the night of the previous day when the herd of 150 heads was counted in the corral. On inspection of the pasture the animal was found dead. The carcass was located and in an advanced stage of decomposition, with the four legs stretched, rigid, and spread apart. Anthrax was suspected by Dr. Angel C. Dizon, farm veterinarian, who, without opening the carcass, collected blood

[1] Died in Manila, June 19, 1939.

smears from the ear vein and jugular vein for microscopic examination. His findings were negative, and seven smears that were forwarded to the Veterinary Research Laboratory for diagnosis again proved negative. The same day another animal, a 10-month-old bull calf, was found moribund. When it died, smears taken from the spleen proved negative on microscopic examination. The remainder of the fresh smear, including two blood smears, were again forwarded to the laboratory for examination and diagnosis. The specimens were once more found negative on microscopic examination. From June 13 to June 20 seven animals died. The blood of the seventh animal was again found negative.

Due to the repeated failures in laboratory examinations to determine the causative microörganisms, it was strongly suspected that septicæmia was responsible for the malady. Hæmorrhagic septicæmia vaccine and anthrax vaccine were shipped to Bongabong with instructions to apply the hæmorrhagic septicæmia vaccine first, pending a final diagnosis. June 20 all buffaloes in the herd were given a single dose of hæmorrhagic septicæmia vaccine. With Drs. A. B. Coronel and Miguel Muñoz, I went to Bongabong for close study of the situation and ocular examination of any recent carcass in the pasture. During two days of inspection in the buffalo herd pasture, all the carcasses seen were in an advanced stage of putrefaction. One of these showed some fresh parts of the body, and smears were obtained from the inguinal vessels and precrural glands which appeared to retain scarlet blood. On examination at the Provincial Hospital Laboratory at Cabanatuan (through the courtesy of Doctor Isip, Director) some Gram-negative bipolar organisms were observed in the smears. Although these findings were by no means conclusive, a telegram was sent to the Director of Animal Industry, stating that "all indications are septicæmia," pending an autopsy of a fresh case.

DISPOSITION OF CARCASSES

All carcasses found in the pasture by the joint party showed putrefaction in harmony with the description given in the preceding paragraph. In nearly all cases they were found at the brim of the mud wallows, suggesting intense thirst on the part of the sick animals shortly before death. It was difficult if not impossible to distinguish the picture of the entire situation from a similar view in an anthrax outbreak. It is in cases such as

these that only the finding and isolation of the causative agent by laboratory methods will settle a dispute or a doubt in the field. The scouting party in a unit arranged field incineration of the carcasses, taking advantage of the liberal supply of firewood lying about the pasture. In every case this was accomplished on the spot. Not being able to find a fresh carcass for nearly 48 hours, we returned to the laboratory pending further developments.

FINAL DIAGNOSIS

June 23, 1938, Dr. Ventura Gatchalian, District Veterinarian of Nueva Ecija and in charge of the vaccination work in the farm, reported the death of a 10-month-old calf 48 hours after vaccination. The carcass was found by him still warm, so he collected fresh blood and a piece of spleen, packed the specimens in ice and sent them to our laboratory, where they arrived at about 4:30 P. M. of the same day. Smears from the blood and spleen were stained and immediately examined microscopically, and again all turned out negative. A series of 2 rabbits, 2 guinea pigs, 2 rats, and 2 mice were gathered and given a subcutaneous injection of blood and another subcutaneous injection of saline suspension of spleen at the rate of 5 cc, 5 cc, 1 cc, and 1 cc, respectively. The next morning after the injection all these animals were found dead. Microscopic examination of their heart blood showed teeming numbers of Gram-negative bipolar organisms of hæmorrhagic septicæmia. The microphotograph in Plate 1 is self-explanatory. The result was immediately telegraphed to Doctor Gatchalian and relayed to Doctor de Guia at the Bongabong Stock Farm in order that proper control measures may be taken at once.

GENERAL VACCINATION

In view of the proximity of the buffalo herd to the cattle herds, and in order to avert a rapid extension of the outbreak, general vaccination with hæmorrhagic septicæmia vaccine prepared by the method of the writer as described in 1935(2) was immediately ordered. Specimens of a grade Indian buffalo steer and pure-bred buffalo bull are shown in Plate 2, figs. 1 and 2. Of 1,589 animals vaccinated in the farm, 150 were buffaloes, 1,432 Nellore and grade cattle, and 90 were work carabaos of tenants and private persons. Fourteen buffaloes in all had already died when vaccination was begun, and only

one buffalo calf 10 months old died 48 hours after vaccination. In this particular animal it was presumed that infection had already set in when the vaccine was administered.

In view of the extreme susceptibility of buffaloes to *Pasteurella* infection, the herd was revaccinated five days after the first injection in order to insure absolute protection. After the general vaccination of all the animals, no more cases appeared, and up to the present writing everything is quiet on the farm..

ISOLATION AND IDENTIFICATION OF THE ORGANISMS

As described in the foregoing paragraphs, considerable difficulty was encountered in the microscopic diagnosis of the smear specimens submitted from the field, where successive examinations also proved negative. This difficulty is a common experience in some laboratories. In some instances even the isolation of the organisms by cultural and animal inoculations has completely failed. A case in point is the report of the writer in "An atypical case of hæmorrhagic septicæmia in the carabao" published in the Bureau of Animal Industry Gazette in 1931.(3) In the present outbreak the last specimen from which the organism was isolated by direct animal inoculation of blood and spleen was negative by microscopic examination, and yet the rabbits, guinea pigs, rats, and mice which received separate injections of blood and spleen emulsion all died in less than 17 hours, showing large numbers of organisms in the blood. Cultures in broth and agar slants from these dead animals contained abundant typical growths of *Pasteurella bipolaris bubalisepticus*. The organisms were nonmotile and Gram-negative, showing the characteristic bipolar staining. (Plate 1.)

Reaction in sugar media.—In dextrose there was acid and no gas; in maltose there was acid and no gas; in inositol, no reaction; in xylose, no change. This finding is characteristic of the group, although it is admitted that variations do occur.

Pathogenicity.—Broth cultures 24 hours old killed in 12 hours rabbits injected with 0.1 cc subcutaneously. The point of injection was hæmorrhagic, and there were no visible lesions in the organs except congestions which characterize high virulence and toxicity.

ORIGIN OF INFECTION

Because the Cabanatuan-Bongabong highway runs through the middle of the stock farm, and in spite of the complete fencing off of the pastures, the origin of infection is difficult to determine. Under the circumstances the following may be considered as having a bearing on the present outbreak. (1) A carabao of the many tenants may have become sick and died inside the farm without the matter having been reported to the superintendent. (2) Portions of infected carcasses may have been carried into the farm by dogs and other animals. (3) The abrupt changes from dry to rainy weather may have activated the organisms in the wallows or soil or in the animals themselves and caused disease. (4) Some other indirect source of contamination may have entered from outside the farm. Although there was no outbreak of septicæmia in the immediate vicinity of the farm at the time, it must be borne in mind that the disease is known to be enzoötic in Nueva Ecija.

SUMMARY

1. An outbreak of hæmorrhagic septicæmia in Indian buffaloes in this country has been described and reported for the first time.

2. It has been shown that in this disease repeated microscopic examination of fixed blood or spleen smears from acute field cases of septicæmia cannot be entirely relied upon as a method of diagnosis.

3. Often even the isolation of the organisms from a carcass by cultural methods and animal inoculation fails.

4. In the outbreak herein reported, in cases where the organisms were isolated by animal inoculation from the blood and spleen specimens, the ordinary smears from these materials were entirely negative on microscopic examination.

5. General vaccination, accompanied by disinfection of wallows and quarantine proved effective means of stopping the outbreak.

6. Of 1,589 animals vaccinated only one died forty-eight hours after injection; this animal may have been infected previous to injection.

ACKNOWLEDGMENT

For their coöperation in conducting the investigation of this outbreak, the writer is indebted to Drs. Pedro de Guia, Angel C. Dizon, A. B. Coronel, Miguel Muñoz, and Ventura Gatchalian, and to Dr. Elpidio Isip, Director of the Provincial Hospital of Nueva Ecija.

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3. TOPACIO, T. An atypical case of hemorrhagic septicemia in the carabao. Bur. An. Industry Gazette (10) 1 (1931) 13.

ILLUSTRATIONS

[Photomicrograph by the author; Winkel-Zeiss microphotographic apparatus; Carl Zeiss microscope, oil immersion; No. 10 ocular, apochromat H190 objective.]

PLATE 1

Heart-blood smear from a rabbit injected with blood from a 10-month-old calf which died June 23, 1938. *p*, organisms of hæmorrhagic septicæmia (*Pasteurella bipolaris bubalosepticus*).

PLATE 2

FIG. 1. A Grade Indian buffalo steer.
2. Pure-bred Indian buffalo bull.

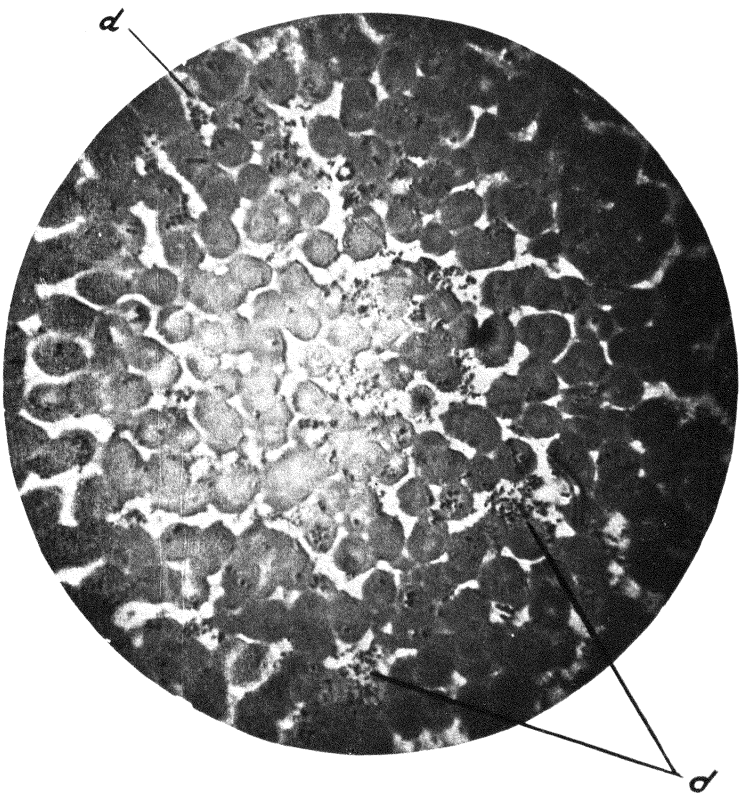
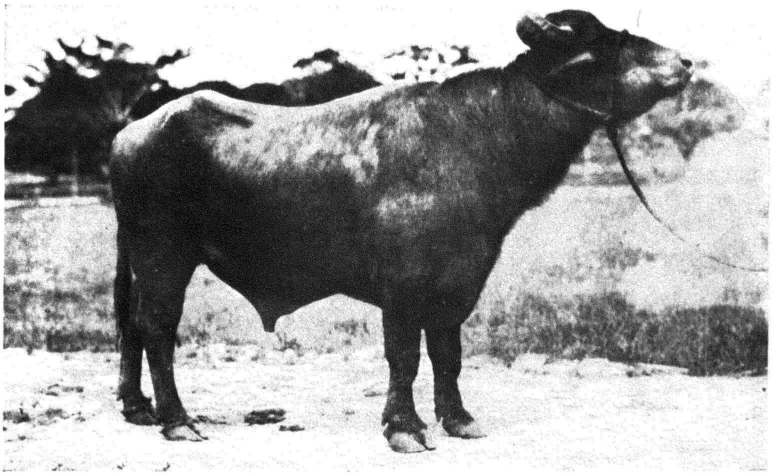


PLATE 1.

1



2

PLATE 2.

SOME NOTES ON THE UTILIZATION OF PHILIPPINE LOW-GRADE CHROMITE [1]

By V. G. LAVA
Of the Division of Chemical Research, Bureau of Science, Manila

In another article [2] the optimum conditions in the roasting of Masinloc chromite for the manufacture of sodium bichromate were reported. The present article has to do with the preliminary experiments on the smelting of this ore and on its treatment with gases, with a view to increasing the chromium content of some of the resulting products.

Intensive concentration experiments with tabling, froth flotation, and electromagnetic methods conclusively point to the fairly homogeneous nature of the ore and to the impossibility of concentrating it by mechanical methods to a chromic oxide content of more than 39 per cent. Accordingly, attention was next centered on the direct smelting of the unconcentrated ore, and on its treatment with gases at high temperatures for its consequent break-up and partial separation into fractions of different chromium: iron ratios.

Experiments on the smelting of Masinloc chromite in the electric furnace.—For the purpose of experiments on the smelting of Masinloc chromite in an electric furnace, a crude furnace of magnesite brick with internal dimensions of 6 inches by 4 inches by 6 inches was constructed. The electrodes used were of 2-inch round carbon. For power, the direct current of the Bureau of Science was used; in order to regulate the current in the furnace, lead plates, immersed in a salt solution, were connected in series to the furnace, and one of the plates raised or lowered, depending upon the power necessary to bring the mixture to a melt.

The analyses of the chromite and reagents used are given in Table 1.

[1] Published with the permission of Mr. V. Elicaño, Technical Director and Vice-President of the Consolidated Mines, Incorporated, Manila. Read before the Fifth Philippine Science Convention, February 23, 1939. Received for publication, March 21, 1939.

[2] Philip. Journ. Sci. 69 (1939) 197.

TABLE 1.—*Analyses of reagents used in smelting.*[a]

Constituents.	Chromite.	Lime.	Coke.
	Per cent.	*Per cent.*	*Per cent.*
SiO_2	5.6	0.1	4.9
Al_2O_3	26.2	0.2	1.8
Fe_2O_3	(17.9)		2.2
FeO	16.5		
Cr_2O_3	33.5	Nil	Nil
CaO	Trace	91.5	Trace
MgO	16.8	Trace	Trace
Volatile combustible matter			6.3
Fixed carbon			83.3

[a] Fluorspar was not analyzed.

The smelting procedure consisted in dumping the mixture of ground chromite, flux, reducing agent, and fluorspar into the small furnace and heating by passing the current through the carbon electrodes which were covered by the mixture. No preheating was done. As soon as the mixture was completely melted, the hole at the bottom was opened, the electrical circuit opened, and the furnace tilted to pour out the melted mass. In some cases it was necessary to tear the furnace apart in order to take out the unattacked ore, reagents, and slag which contained a portion of the reduced metal.

Table 2 gives the results of smelting with variations in the percentages of lime and coke. It appears from this table that the optimum mixture of chromite, lime, and coke, with the use of 0.11 per cent fluorspar, is 1: 0.20–0.30: 0.25–0.30, or more specifically, 1:0.23:0.28. The ferrochrome produced is of commercial grade, and the impurities in it are not all carbon, analysis showing that the carbon content of the metal is about 1 to 3 per cent less than the total impurities.

The energy consumption per kilo of ferrochrome appears high,[3] but it must be pointed out that no preheating was done, that no attempt was made to decrease heat loss through radiation, and that the method of charging was such that the whole field of reaction in the furnace was not utilized. Furthermore, in none of the experiments could a voltage of 50 or less be used, due to the limitations of the ammeter used, so that energy losses

[3] See P. Bogetch, Compt. rend. (1933) 197, 1417–1419; D. A. Lyon, R. M. Keeney, and J. P. Cullen, The Electric Furnace in Metallurgical Work, U. S. Gov't Printing Office, Washington (1916) 127–141; Volianisk, Journ. pour Elec. (1934) 43, 90, 91.

Table 2.—*Effects of different amounts of lime and coke on the smelting of Masinloc chromite.*

[1000 grams chromite were used per charge.]

[Fluorspar, 11 grams.]

Experiment.	Coke.	Lime.	Power.	Charging time.	Extraction.	Chromium in metal.	Iron in metal.	Impurities.	Remarks.
	g.	*g.*	*kw.*	*Hours.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	150	150							No fusion.
2	250	150	9.0	0.6	28	61.5	30.0	8.5	Difficult to obtain fluid slag.
3	300	150	10.0	1.2	83	58.4	32.4	9.2	Very viscous slag.
4	150	200	5.6	1.0	33	59.6	34.6	5.8	Difficult to melt slag.
5	250	200	6.5	1.0	93	63.2	30.4	6.4	Fluid slag at 8 kw.; porous metal.
6	300	200	7.7	1.4	106	56.8	28.4	14.8	Fluid slag at 8.5 kw.; carbide odor.
7	350	200	6.3	1.4	64	60.0	33.7	6.3	Very viscous slag.
8	150	300	5.0	1.2	53	54.8	40.0	5.2	Fluid slag; porous metal.
9	250	300	4.8	2.0	94	59.8	30.5	10.2	Fluid slag around 5.5 kw.
10	300	300	5.7	1.8	99	58.4	30.6	11.0	Fluid slag.
11	350	300	7.0	1.9	86	58.6	31.8	9.6	Fluid slag at 8 kw.
12	150	375	6.2	1.0	58	56.8	37.9	5.3	Fluid slag at 10 kw.
13	250	375	6.5	1.4	81	60.0	31.1	8.9	Fluid slag at 8.4 kw.
14	300	375	6.1	1.8	99	58.4	29.3	12.3	Fluid slag at 6.6 kw.
15	350	375	6.1	1.5	95	58.6	32.3	9.1	Fluid slag at 8.6 kw.

were high. For a fairly accurate determination of energy consumption per kilogram of ferrochrome, a semicommercial furnace would be necessary, or at least one with an automatic arrangement for maintaining current flow.

As long as power is cheap, and since with the Udy [4] process ore with as low as 18 per cent chromic oxide can be commercially treated, power consumption should not be a deterent factor for the utilization of Masinloc chromite.[5]

Experiments on the chlorination of Masinloc chromite.—Besides mechanical treatment, various methods have been proposed to increase the Cr:Fe ratio of the ore for the manufacture of ferrochrome. These methods apply to either low-grade chromite or ferrochrome low in chromium.

British Patent 176,729 (1920) proposes the crushing and washing of chromite and treatment at 900°C. with a mixture of HCl and H_2. In this way ferric chloride is volatilized; and by afterwards raising the temperature of the furnace to 1,200°C. and passing Cl_2 over the residue, the chromic chloride is volatilized separately and can be further treated for smelting purposes.

British Patent 269,029 (1926) starts with ferrochrome and calls for the use of Cl_2 or gases containing chlorine to attack the metal, the heat produced after the reaction starts being sufficient to maintain the reaction. In this way the iron chloride sublimes at one end of the furnace, while the chromium chloride may be continuously withdrawn at the other end. Small quantities of reducing agent, such as CO with Cl_2 or carbon, may be mixed with the ferrochrome.

In British Patent 305,712 (1927), chromium ores are given preliminary "opening up" treatment by heating and quenching in water or by melting with 5 per cent or more of an alkali reagent in a nonoxidizing atmosphere. The mixture is then treated at 500° to 600°C. with HCl or Cl_2 or both, with or without reducing agents. In this way there is left a residue of either the chloride or oxide of chromium, depending on the gas used.

British Patent 256,433 (1925) does not use chlorine compounds, but increases the chromium content of the metal by

[4] Udy, Marvin J., British Patent 437,008, Oct. 22, 1935; Canada Patent 357,274, April 21, 1936.

[5] Personal information has been obtained from Mr. V. Elicaño that Masinloc chromite has been successfully used with the Udy process on a commercial scale in the United States.

decreasing its carbon content. In this patent the ore is mixed with an oxygen-containing sodium compound and carbon, and the mixture is smelted in a blast furnace. Any chromium carbide formed is decomposed by introduction of sodium chromate through the truyeres.

Our experiments with Masinloc chromite make use of chlorine, hydrogen chloride, or both, and coconut charcoal as the reducing agent. The reaction was carried out in a long silica tube heated by an electric furnace. The gases were first dried in H_2SO_4 before they were allowed contact with the mixture of ore and carbon. Table 3 shows the results of concentration of the ore with HCl and Cl_2 gases, and the effect of temperature on the extent of the reaction and ease of separation.

In experiments 1 to 7 chlorine gas alone was used, and in experiments 8, 10, 11, and 12, hydrogen chloride alone. In experiment 9 a mixture of chlorine and HCl was used, and in experiment 13, HCl alone, followed by chlorine alone.

The products of concentration when chlorine is used may be conveniently divided into four fractions; (1) distillate remaining in the glass tube outside the silica tube; (2) distillate remaining at the end of the silica tube; (3) distillate mostly of $CrCl_3$ and $FeCl_3$, which remains nearest the residue and is pink; and (4) the gray residue which is in the form of cakes. Part of the chloride distillate is absorbed in the alkali bottle after the glass-tube fraction. With the use of HCl gas no division into the above fractions is noted; instead there is a slight amount of distillate in fractions 1 and 2, but most of the substance is in the residual fraction.

Experiments 1 to 4 show that when chlorine gas is used alone some chromium is lost to fractions 1 and 2 in the form of chloride, and the greater the amount of reducing agent used the greater the loss of chromium in fractions 3 and 4. Also, for the same ratio of chromite to carbon (experiments 5 to 7), the lower the temperature, the greater the amount of iron recovered in fractions 3 and 4. In experiment 7 the temperature is so low that the carbon was hardly attacked.

When HCl is used, for the same mixture of chromite and carbon (experiments 8, 10, 11, and 12), the higher the temperature the greater the recovery of chromium in the residue; while the iron recoveries are also fairly high, though lower than those for chromium.

TABLE 3.—*Chlorination of Masinloc chromite.*[a]

Experiment.	Carbon.	Furnace temperature.[a]	Preheating time.	Apparent reaction time.	Gases used.	No. of b··bbles per second	Products.							
							Fraction 1.				Fraction 2.			
							Weight.	Cr.	Fe.	Cr: Fe.	Weight.	Cr.	Fe.	Cr: Fe.
	g.	°C.	Min.	Hours.			g.	Per cent.	Per cent.		g.	Per cent.	Per cent.	
1	1.2	700	45	1	Cl	3.3	0.52	10.0	6.0	1.7	3.18	10.0	7.9	1.3
2	0.8	700	45	1	Cl	3.0	0.40	11.5	10.4	1.1	1.81	8.9	8.9	1.0
3	0.4	700	45	1	Cl	3.0	0.25	3.6	14.5	0.25	1.07	12.5	10.5	1.2
4	0.0	700	45	1	Cl	3.0	0.02	-----	-----	-----	-----	-----	-----	-----
5	0.72	700	45	1	Cl	2.7	0.23	-----	-----	-----	0.95	8.3	9.3	0.9
6	0.72	630	45	1	Cl	2.7	0.10	-----	-----	-----	1.62	1.2	12.3	0.1
7	0.72	570	45	1	Cl	2.7	-----	-----	-----	-----	0.40	5.7	18.0	0.3
8	0.72	630	45	1	HCl	2.5	-----	-----	-----	-----	-----	-----	-----	-----
9	0.72	630	45	1	HCl & Cl	3.0	-----	-----	-----	-----	1.40	6.4	11.3	0.6
10	0.72	700	45	1	HCl	2.5	-----	-----	-----	-----	0.07	-----	-----	-----
11	0.72	770	45	1	HCl	3.0	-----	-----	-----	-----	-----	-----	-----	-----
12	0.72	830	15	1	HCl	3.0	-----	-----	-----	-----	-----	-----	-----	-----
13	0.72	630	30	0.5 & 0.5	HCl & Cl	3.0	-----	-----	-----	-----	0.34	-----	-----	-----

Experiment.	Products.								Recovery of metal.[b]				Cr: Fe in fractions 1 and 2.	Cr: Fe in fractions 3 and 4.
	Fraction 3.				Fraction 4.				Cr in fractions 1 and 2.	Fe in fractions 1 and 2.	Cr in fractions 3 and 4.	Fe in fractions 3 and 4.		
	Weight.	Cr.	Fe.	Cr: Fe.	Weight.	Cr.	Fe.	Cr: Fe.						
	g.	*Per cent.*	*Per cent.*		*g.*	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
1	1.22	18.6	7.3	2.6	2.05	5.1	1.4	3.5	41	57	37	35	1.3	1.91
2	1.60	16.0	11.0	1.5	2.76	14.1	3.1	4.6	23	41	72	52	1.0	2.47
3	1.18	11.5	14.8	0.8	3.08	21.0	8.8	5.6	15	30	86	55	1.0	2.84
4	0.12				3.58	24.7	8.3	3.0			96	60		2.96
5	2.14	10.7	1.5	7.1	2.80	21.5	6.7	3.2	9	18	91	44	0.9	3.77
6	0.15				3.57	18.1	6.4	3.0	2	40	71	45	0.1	2.86
7					5.45	16.2	7.9	2.1	3	14	95	86	0.3	2.06
8					3.61	21.8	9.7	2.3			87	70		2.26
9	0.60	10.8	12.1	0.9	3.25	19.4	5.0	3.9	10	28	77	47	0.6	2.96
10					3.57	23.7	9.0	2.6			93	62		2.62
11					3.75	23.5	10.5	2.3			97	89		2.25
12					3.78	24.3	11.1	2.2			100	84		2.18
13					3.65	21.5	9.3	2.3			87	68		2.32

[a] 4 grams were used.

[b] Based on original chromite.

The ratios of metallic chromium and iron are calculated for the combined fractions 3 and 4. In the original chromite this ratio is 1.8; and it is clear that in all the experiments there was an increase in the ratio in the combined fractions 3 and 4, varying from 1.9 to 3.8. When we consider that for a ferrochrome of the composition Cr : Fe : C = 70 : 25 : 5, the ratio of Cr to Fe is 3, while for an alloy of composition Cr : Fe : C = 68 : 27 : 5, the ratio of Cr to Fe is 2.5, it is clear that such compositions of ferrochrome may be obtained by heating chromite with or without carbon and passing either chlorine gas alone or HCl alone or a mixture of the two, at a fairly high temperature.

SUMMARY AND RECOMMENDATIONS

1. Preliminary experiments on the smelting of low-grade Masinloc chromite show that commercial ferrochrome may be obtained from this ore, and that the optimum mixture of chromite:lime:coke is around 1:0.23:0.28. In order to show the competative position and the actual value of the Masinloc chromite reserve, it will be necessary to carry on in the Philippines further smelting experiments on a semicommercial scale, especially with the use of the Udy process.

2. Preliminary experiments on the chlorination of Masinloc chromite further indicate that certain fractions of chlorination are obtained which yield a ratio of Cr:Fe higher than 2.5, thus ensuring an even higher ratio of Cr:Fe in the production of ferrochrome. Clorination without carbon shows good possibilities.

CHEMICAL ANALYSIS AND VITAMIN ASSAYS OF OPIHI, THE HAWAIIAN LIMPET[1]

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ONE PLATE AND ONE TEXT FIGURE

There is little or no scientific information available regarding the nutritive value of the many mollusks and crustaceans formerly used as food by the Polynesians in the Pacific, and still used, to a greater or less extent, by groups depending on the sea for an important part of their sustenance.

The opihi, or Hawaiian limpet, was one of the favorite shellfishes of the ancient Hawaiians. The natives have names for a number of varieties and sizes of opihi, although only two, *Helcioniscus exaratus* Nuttall and *H. argentatus* Sowerby, have been given scientific names, apparently on the basis of shell shapes. There seem to be intermediate shapes that cannot always be clearly distinguished even by scientists.

According to our Hawaiian informants, opihi were formerly found on all the islands the year round and eaten by all classes of people. The soft parts of the opihi mixed with *poi*[3] constituted one of the first foods fed to Hawaiian infants in addition to mother's milk in olden days. Opihi are usually eaten raw, either fresh or salted, frequently with certain seaweeds; they are sometimes cooked, but in this form are tougher than raw. Ethnologists state that in olden days opihi for use as food were taken inland distance requiring several days' travel, as evidenced by the opihi shells found in caves on the slopes of Mauna Kea and Mauna Loa mountains on the island of Hawaii, and in the crater of Haleakala on Maui. They have recently

[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station. Since the above article was written, Mr. M. E. Nelson and Dr. S. S. Ballard, of the Physics Department of the University of Hawaii, have shown by spectrographic methods that the vitamin A activity of the hepato-pancreas of the opihi is due entirely to carotene. The characteristic absorption band of vitamin A could not be detected, whereas the β-carotene bands were prominent.

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[3] A smooth paste made by cooking, grinding, and pounding corms of taro (*Colocasia esculenta*).

been found, along with kukui shells, in some of the bubble caves on Mauna Kea at an elevation of about 12,500 feet.(13)

Opihi can usually be bought on the Honolulu markets today, but they have become a luxury, selling at for 25 to 30 cents per pound in the shells. Approximately 35 per cent of the mollusk is edible, so that the edible portion costs approximately 80 cents per pound.

The nutritive value of two Mollusca of the Lamellibranchia class, oysters and clams, has been investigated in recent years, but no work has been reported on the Gastropoda, the class to which the opihi belong. The studies herein reported were undertaken to determine the various nutritive elements of this shellfish.

CHEMICAL ANALYSIS OF OPIHI

Methods.—The methods employed in the determination of the organic nutrients were those of the Association of Official Agricultural Chemists,(2) with the following exceptions: glycogen was determined by two methods explained hereafter; calcium by the McCrudden volumetric method;(17) iron by the method of Elvehjem and Hart;(11) and copper by the method recommended by Elvehjem and Lindow(12) for materials rich in iron. For the iron analyses precautions taken to prevent contamination included avoiding the use of iron utensils, ashing the material without previous drying, and subtracting the iron value of a blank determination run simultaneously. Copper determinations were guarded in a similar manner.

All analyses, except those for glycogen, were made on opihi bought at the local retail fish market. The opihi were, for the most part, alive when prepared for analysis; but, as they were shipped to Honolulu from the nearby islands, they had been out of their natural habitat for 24 hours or longer. The analyses given in Table 1 for the two portions, foot and mantle, and the viscera of the opihi were made on a composite sample prepared from about 7 pounds [4] of opihi in the shell, 1,220 grams of edible portion. The foot and mantle, constituting the tougher portion of the shellfish, and the viscera or soft parts, including the digestive tract, hepatopancreas, and gonad, were analyzed separately, and the composition of the whole was calculated from the proportion of each, which made up the original material. The composition of the whole thus calculated agrees almost exactly with analyses made on two separate samples of whole

[4] 3.2 kilograms.

opihi at intervals of several years. It is, therefore, believed that the figures in Table 1 represent satisfactory averages for the composition of whole opihi.

Samples of live opihi purchased at the fish market in Honolulu and of opihi taken directly from the rocks in the ocean were analyzed for glycogen by two methods—Carruthers(7) and the modified method given by the Association of Official Agricultural Chemists.(2) In order to prevent changes in the glycogen content after removal from the rocks, the opihi were immediately shelled, weighed, and placed in boiling water for the Carruthers method or in potassium hydroxide solution for the Association of Official Agricultural Chemists' method; the analyses were completed later at the laboratory. After extraction and hydrolysis of the glycogen, the resulting glucose was determined, first by the Allihn gravimetric method and then by the volumetric thiosulfate method.(2)

Results.—The figures for the chemical composition of opihi given in Table 1, as compared with those reported for other shellfish,(20) indicate that the percentage of protein in whole opihi is greater than in clams, and much greater than in oysters or mussels; all of these shellfish are low in fat, of which they have less than 2 per cent. Opihi are a better source of calcium, phosphorus, and iron than are clams or oysters, but the quantity of copper in opihi is smaller than that reported for oysters.(16) Table 1 shows that the viscera, commonly spoken of as the soft parts of the opihi, contain relatively greater percentages of fat, calcium, phosphorus, and iron than does the foot and mantle portion. Opihi, like most products of the sea, are a good source of iodine(4) containing 4,480 parts per billion of the dried material, or about 1,050 parts per billion of average fresh material.

The analyses of opihi for glycogen, summarized in Table 2, show that the Carruthers method was not satisfactory for the extraction of this substance from the tough foot and mantle. By the Association of Official Agricultural Chemists' method, involving potassium hydroxide solution which caused disintegration of the tissue, the foot was shown to have a much greater percentage of glycogen than the viscera. The total quantity of glycogen in the whole opihi taken directly from the sea did not vary greatly from that of live animals from the market which had been out of the water for some time. Whole opihi contain about 1 per cent of glycogen, a quantity one-third to one-fourth that found in such sea foods as abalone, mussels, and oysters.(20)

TABLE 1.—*Chemical composition of opihi expressed as per cent of fresh edible material.*

Part.	Moisture.	Protein (N x 6.25).	Ether extract.	Ash.
Foot and mantle	77.8	18.8	0.3	1.52
Viscera (total soft parts)	73.3	13.3	5.5	4.05
Whole [a]	76.6	17.3	1.7	2.21
Viscera without gonads	75.5	12.0	1.6	4.60
Ovaries	62.6	23.9	8.7	1.74
Testes	76.0	20.0	2.2	2.45

Part.	Calcium.	Phosphorus.	Iron.	Copper.	Silicon.
Foot and mantle	0.052	0.122	0.00204	0.00011	0.04
Viscera (total soft parts)	0.698	0.211	0.04536	0.00008	0.28
Whole [a]	0.230	0.146	0.01395	0.00010	0.11
Viscera without gonads	1.174	0.163			0.16
Ovaries					
Testes					

[a] Calculated from analyses of foot and mantle, and viscera given above (72.2 per cent foot and mantle, 27.5 per cent viscera).

TABLE 2.—*Glycogen content of opihi tissues expressed as per cent of fresh edible material.*

Method.	Source.	Whole.	Foot and mantle.	Viscera.
		Per cent.	*Per cent.*	*Per cent.*
Carruthers	From market	[a] 0.11	0.04	0.27
Do	From sea	0.13	0	0.18
Do	do	0.21		
A. O. A. C. [b]	From market	[a] 0.96	1.27	0.22
Do	From sea	[a] 1.00	1.23	0.47
Do	do	1.11		
Do	do	1.02		

[a] Calculated from analyses of foot and viscera (70 per cent foot, 30 per cent viscera).
[b] Association of Official Agricultural Chemists.

THE VALUE OF THE OPIHI FOR HÆMOGLOBIN REGENERATION

Whipple and Robscheit-Robbins(26) have shown fish liver and whole fish to be almost inert for hæmoglobin regeneration in dogs, whereas mammalian liver is very potent. On the other hand, Levine, Remington, and Culp(16) have found oysters to be effective in curing nutritional anæmia in the rat. An experiment to investigate the hæmoglobin regenerating value of another shellfish, the opihi, is reported below.

Nutritional anæmia was produced in 55 young albino rats by a diet exclusively of milk. The methods of feeding and blood

sampling have been previously reported.(14) The results of experiments with anæmic rats fed opihi supplements with and without added iron or copper are summarized in Table 3. Daily supplements of 4 grams of whole opihi for 55 days resulted in considerable increase in weight but poor regeneration of hæmoglobin. Daily supplements of 4 grams of whole opihi plus iron for 19 days had little or no value in regenerating hæmoglobin, but when 0.01 milligram of copper, in the form of a basic copper-sulphate solution, plus 4 grams or even 2 grams of opihi were fed daily, the hæmoglobin reached almost normal levels after about 8 weeks. Chemical analyses of whole opihi reported in Table 1 show that this shellfish contains a relatively large percentage of iron but a small percentage of copper. It is, therefore, not surprising that the addition of even minute amounts of copper to the opihi supplements resulted in good hæmoglobin regeneration, whereas the addition of iron in the form of ferric chloride had no significant effect.

TABLE 3.—*Hæmoglobin regeneration in anæmic rats fed opihi.*

Kind and quantity of supplement fed daily.	Number of rats.	Days supplement was fed.	Average weight of rats. When started on supplement.	Average weight of rats. Final.	Average hæmoglobin. When started on supplement.	Average hæmoglobin. Final.	Relation of spleen weight to total weight.
			g.	*g.*	*g.*	*g.*	*Per cent.*
None (control)	7	--------	67	65	3.4	2.7	0.32
Iron, 0.5 milligram	5	40	64	83	4.2	4.7	0.33
Opihi, 4 grams	28	55	86	131	4.2	6.1	[a] 0.59
Opihi, 4 grams; Iron, 0.5 milligram	3	19	[b] 104	117	3.6	3.8	--------
Opihi, 4 grams; Copper, 0.01 milligram	8	59	62	184	3.8	12.1	0.32
Opihi, 2 grams; Copper, 0.01 milligram	4	53	59	168	4.1	12.1	0.31

[a] Average of 26 rats, 2 rats having died and their spleens not having been weighed.

[b] Weight when iron supplement was started. Rats have been fed opihi supplements for 4 weeks previously, which resulted in gains in weight but not in hæmoglobin regeneration.

The enlarged spleens found at autopsy in anæmic rats fed opihi without other supplements have been found in all anæmic rats at that period of recovery when the hæmoglobin reaches a level of about 6 to 8 grams per 100 ml of blood. Detailed studies of this work have been reported elsewhere.(14)

VITAMIN VALUE OF OPIHI

The methods used for the determination of the vitamin contents of opihi were essentially those recommended by Sherman,(19) and except for vitamin D have been fully described elsewhere.(18) The international standards were used for the vitamin A and part of the vitamin D tests, but were not available at the time the vitamin B and vitamin C tests were made. For the vitamin B_2 (G) tests an extract of tikitiki was used to supply vitamin B_1 instead of the alcoholic extract of whole wheat recommended by Bourquin and Sherman.(6)

To prepare the whole opihi for feeding, the radulæ were discarded, the viscera were separated and placed in a beaker, and the foot and mantle portion was finely minced with a board and knife used solely for that purpose. The minced material was then intimately mixed with the viscera. The viscera, without gonads, consisting mostly of digestive tract and hepatopancreas, were freed of a bit of membranous material and made into a homogenous mixture. The small feedings given twice a week were accurately and quickly weighed on tared watch glasses and immediately fed to the rats which ate all the opihi and licked the glasses clean.

VITAMIN A

Experimental.—Two hundred eighteen rats were used to determine the vitamin A value of opihi. The kind and quantities of supplements fed are listed in Table 4.

The carotene was carefully prepared from the international standard involving the use of purified cottonseed oil through which dry carbon dioxide had been bubbled for 3 hours. The cottonseed oil had been proved by feeding tests to be without vitamin A activity. The supply of prepared carotene was kept in the dark in small vials in an atmosphere of carbon dioxide at about 0°C. Not more than 1 week's supply was transferred to an electric refrigerator at a time, and the amount used each day was removed as needed. The carotene was fed by calibrated pipettes 3 times per week.

For vitamin A experiments we find it impossible to keep rats in good condition and have most of them survive the experimental feeding period, unless the gains in body weight are relatively large. The rats in series 1, 2, and 3 were all 3 weeks of age when placed on the diet and, as shown in Table 4, averaged about 40 grams in weight. However, their average weight

TABLE 4.—*Results of feeding various amounts of opihi to rats as the sole source of vitamin A.*

Supplements.	Number of rats.	Supplement fed weekly.	Average weight.			Average gain in six weeks.
			Initial.	When supplement started.	Final.	
FIRST SERIES			g.	g.	g.	g.
Negative control	15		40	[a] 124	87	
International standard, carotene	4	18 units	41	107	156	49
Do	9	24 units	43	126	214	88
Opihi, whole	10	0.3 gram	40	110	163	53
Do	7	0.4 gram	42	124	201	77
Opihi, foot	6	1.0 gram	40	141	178	37
Do	12	2.0 grams	40	128	193	65
Opihi, viscera without gonads	15	0.05 gram	40	134	183	49
Do	9	0.1 gram	42	119	175	[b] 56
Opihi, ovaries	10	0.2 gram	41	126	201	75
Opihi, testes	13	0.1 gram	39	120	175	55
SECOND SERIES						
Negative control	5		40	[a] 126	90	
International standard, carotene	11	24 units	41	130	234	104
Opihi, whole	9	0.4 gram	41	124	219	95
Opihi, viscera without gonads	7	0.05 gram	38	126	201	75
THIRD SERIES						
Negative control	4		46	[a] 170	107	
International standard, carotene	4	24 units	41	128	229	101
Opihi, whole	7	0.5 gram	42	142	241	99
Opihi, viscera without gonads	6	0.08 gram	43	133	222	89
FOURTH SERIES						
Negative control	7		33	[a] 82	82	([b])
International standard, carotene	12	6 units	32	79	157	[b] 78
Do	12	12 units	33	79	178	[b] 99
Opihi, whole	12	0.3 gram	30	77	174	[b] 97
Do	12	0.5 gram	31	81	194	[b] 113

[a] Weight at end of the depletion period. [b] Fed for five weeks only.

was usually well above 100 grams before they showed plateauing or loss of weight. The results of the experiments listed under series 1, 2, and 3, which were completed 4 years previously, might be criticized as not showing sufficient refinement of method, both because of the large gains in weight during the feeding period and because the number of rats fed the standard was not always equal to the number fed the substance tested. A fourth series of experiments was therefore conducted.

The vitamin A stores of the experimental animals in series 4 were reduced by changing the good breeding diet of the mothers to a diet of skim milk and ground whole wheat one week after

the young were born; this low vitamin A diet was the only one to which the young rats had access before they were placed at 3 weeks of age on the vitamin A-free diet previously described.(18) On the vitamin A-free diet such rats react quite uniformly; they gain rapidly for about 3 weeks and then the weight drops. If the rats are continued on the vitamin A-free diet, xerophthalmia invariably appears along with other signs of vitamin A deficiency—lung, kidney, and bladder infections, pus at the base of the tongue, and injury to the nerves which causes dragging of the hind legs. If the weights of the rats are allowed to become stationary or drop slightly before the feeding of supplements is begun, a large proportion of the rats show serious infections and may succumb before the end of the experimental period. For series 4, therefore, 7 litters of rats, prepared as indicated above, were placed on the vitamin A-free diet; after 2 weeks one rat from each litter was selected as a negative control and the remainder were divided into four groups fed supplements as follows: 1 unit international standard carotene daily or 6 units weekly; 2 units daily or 12 units weekly; 0.3 gram whole opihi weekly; and 0.5 gram whole opihi weekly. Care was taken to divide the litters in such a way that each group contained the same number of rats of each sex and of about the same weight. Except for the control group, which contained 5 males and 2 females, each group of 12 rats comprised 5 males and 7 females.

As can be seen from text fig. 1, all groups of rats showed equally rapid growth during the first week, after which the weights of the negative controls dropped while those of the other rats receiving the supplements continued to increase. Starting the supplement feeding before complete depletion of the vitamin A stores kept the rats in good condition, so that those receiving the smallest quantity of vitamin A from the supplements lived out the experimental period of five weeks without showing many signs of deficiency, as rats in our colony do when depleted of vitamin A stores until the growth curve drops or plateaus and then are fed 1 unit of vitamin A for 6 days a week.

In addition to the above experiments, 55 rats were used for the 1-feeding method recommended by Sherman and Todhunter.(22) The results were unsatisfactory, because the growth response and period of survival were not increased in proper

proportion as the quantity of supplement was increased; they are, therefore, not reported here.

Data and discussion.—From the data presented on the first three series (Table 4) one may conclude that whole opihi contain 4,500 to 5,000 units of vitamin A per 100 grams of fresh material; that the foot and mantle portion of the opihi contain much less vitamin A than the viscera without gonads; and that the testes contain about the same quantity of vitamin A as the viscera without the gonads and a somewhat greater quantity of vitamin A than the ovaries.

Table 4 and text fig. 1 summarize the experimental data for the rats of series 4 which had smaller stores of vitamin A when placed on the vitamin A-free diet, but whose reserves of vitamin A were not exhausted before the supplements were started. The average curves of the 2 groups of rats fed 0.3 gram whole opihi weekly and 12 units of the vitamin A standard weekly coincide so closely that it is difficult to distinguish between them. Judging the vitamin A value on this basis, fresh whole opihi contain 40 units per gram or 4,000 international units per 100 grams instead of 4,500 to 5,000 units as shown by the first three series of experiments. The value of 4,000 per 100 grams compares favorably with that of 5,000 international units for average butter and egg yolk reported by Sherman (1932); however, many samples of these two foods show much lower values.(10) Whole opihi contain an average of 76.6 per cent moisture; thus, moisture-free opihi would contain 17,000 international units per 100 grams, about one-tenth as much as good cod-liver oil. However, in the fresh state opihi may be considered an excellent natural food source of vitamin A and must have been an important source of this vitamin in the diet of the ancient Hawaiians.

VITAMIN B_1

To determine the vitamin B_1 content of opihi, 31 rats, weaned at 4 weeks of age and weighing 51 grams on the average, were placed on the vitamin B-free diet recommended by Sherman.(19) After less than three weeks on this diet the vitamin B stores of the rats were exhausted when feeding of the opihi supplements was started. Twenty-three rats fed 4 grams of opihi daily sustained an average loss of 23 grams during an 8-week feeding period (Table 5). Four rats fed 6 grams daily gained an average of only 4 grams in 8 weeks. These results prove opihi to be a very poor source of vitamin B_1.

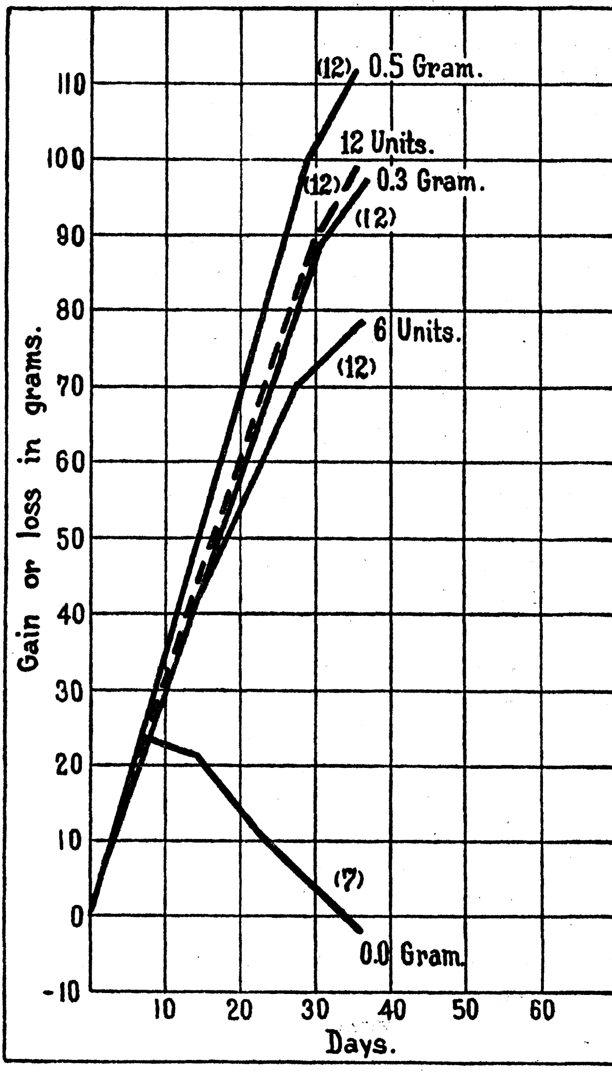

FIG. 1. Average gain in weight of groups of young rats fed opihi and the international standard carotene. The quantities indicated were fed weekly. The numbers in parentheses show the number of rats used for each test.

VITAMIN B_2

The Bourquin-Sherman (6) method for determining the factor until recently called vitamin B_2 or G has been shown by a number of investigators to be a test for flavin. (3) Unpublished results from this laboratory show that, when the other factors of

TABLE 5.—*Results of feeding various amounts of opihi to rats as their sole source of vitamins B_1 and B_2 (G).*

Vitamin studied and source.	Number of rats.	Weight of supplement fed daily.	Average weight.			Average gain or loss in 8 weeks.
			Initial.	When supplement started.	Final.	
Vitamin B_1:		g.	g.	g.	g.	g.
Negative control	4	0	52	[a]74	50	
Opihi, whole	23	4.0	51	74	51	−23
Do	4	6.0	48	68	72	+ 4
Vitamin B_2 (G):						
Negative control	4	0	54	[a]73	75	+ 2
Opihi, whole	14	0.5	55	76	96	+20
Do	17	1.0	54	72	115	+43

[a] Weight at end of depletion period.

the vitamin B complex are supplied by an extract of rice polishings, rats respond with increased increments of growth proportional to the quantities of pure flavin fed, up to 15 γ. The tests here recorded, made in 1931–1932, were, therefore, a test for flavin.

Thirty-five rats used in the experiment were placed on the Bourquin-Sherman vitamin G-free diet at 4 weeks of age, at which time they averaged 54 grams in weight. The weights remained almost stationary after 33 to 35 days on this diet, when feeding of opihi began. The results summarized in Table 5 show that 14 rats, fed 0.5 gram of whole opihi daily, gained an average of 20 grams in 8 weeks or 2.5 grams per week, and 17 rats fed 1 gram of opihi daily gained 43 grams in 8 weeks or 5.4 grams per week. The quantity of opihi that would permit the unit rate of gain of 3 grams per week must lie between 0.5 and 1 gram daily and would probably be less than 0.75 gram. Opihi, therefore, contain about 1.3 vitamin B_2 (G) units, or 2 to 2.5 γ flavin(3) per gram; or about 130 Sherman-Bourquin units, or 300 γ flavin per 100 grams. Opihi are at least as good a source of this factor as average lean beef and whole eggs, and are better than average milk.(10)

VITAMIN C

Seventeen standard young guinea pigs were fed Sherman's(19) scorbutic diet plus fresh alfalfa until 11 of them were induced to eat opihi. Two were then continued on the basal diet plus supplements of alfalfa and used as positive controls; four were fed on the basal diet or 21 days and served as negative controls;

seven were fed supplements of 2 grams of whole opihi daily; and four were fed 4 grams of opihi daily for 21 to 28 days.

The guinea pigs fed opihi and the negative controls showed equally severe gross scurvy at autopsy, and histological examination of the teeth of both groups showed no protection whatever. The positive controls were completely protected from gross scurvy and their teeth showed no histological changes. The conclusion may be drawn that opihi contain no demonstrable quantity of vitamin C. In order to save space, no protocols are given.

VITAMIN D

Experimental.—Two hundred and thirty-seven rats were used for the vitamin D experiments; 189 were fed supplements and the others were used as negative controls. Rats 28 or 29 days old and weighing, with few exceptions, between 55 and 60 grams, were given the Steenbock yellow corn ration No. 2965.(23)

After 21 days one rat from each litter was killed and one was continued on the basal diet without supplement until the 29th day, both being considered negative controls. Beginning on the 21st day the other rats in each litter were fed various supplements for 8 days and were then killed the 29th day after the rickets-producing diet was begun. In the first experiments (series A), one or more rats of each litter, fed a good grade of commercial cod-liver oil, served as positive controls. After the international standard irradiated ergosterol and reference cod-liver oil were made available, further experiments (series B) were conducted, in which several rats from each litter were fed these supplements at two different levels. Near the beginning of the experiments, 5 litters of 52 rats of series A were used to compare the results of bone analyses with the results of the line test. The tibias were used for the line test and the femurs for the chemical analyses. The femurs were carefully removed and freed of all adhering material, weighed, and ashed as recommended by Sherman and Stiebeling.(21) Total ash and calcium of the fresh femurs, and the percentage of calcium in the ash, were determined.

Five of the positive control rats in series A, fed a diet containing 1 per cent cod-liver oil, failed to gain in weight. As these positive controls without exception showed a 4+ healing they were not discarded. As one rat, fed 0.5 of a unit of the international standard per day, lost 4 grams in weight, his record was discarded. Bills et al.(5) have warned against the use

of animals that fail to gain weight, as such a reaction may cause healing even when no curative supplement is given.

At autopsy both tibia were removed from each rat and preserved in 10 per cent formalin until the line test(5) was applied. The bones were studied under a low-power binocular microscope, and the degrees of healing rated as recommended by Bills et al.: — (no healing), 1+, 2+, 3+, and 4+ (healing). Photographs were made of the line tests of about half the animals, and the degrees of healing exhibited in the photographs were compared with the ratings made directly from the bones.

Data and discussion.—The results of the chemical analyses of the femurs of 52 rats are summarized in Table 6. Although 3 grams of opihi per day induced, on the average, better than 3+ healing of rickets, and 4 grams almost 4+ healing, the quantity of ash or of calcium in the fresh femurs, or of calcium in the ash, bears no consistent relation to the degree of healing in comparison with the results for either the negative or the positive controls. In every case the supplements were fed for only 8 days, which may have been too short a period to influence the ash and calcium of the bones. No attempt was made to keep the food intake of all the rats similar. The average gains in body weight during the 8 days of supplementary feeding are similar for the various groups of rats fed whole opihi, the viscera, and the gonads, yet the total ash and calcium in the fresh femurs is greater for those that received the ovaries and testes than for those fed the other opihi supplements, and the total ash compares favorably with that of the rats in the cod-liver oil group. However, the average gain in weight of the 5 rats fed cod-liver oil was only 2 grams for the 8-day feeding period. It was concluded that ash analyses are of no value in determining the vitamin D value of a food when short feeding periods are used, a conclusion reached by Tabor, Dutcher, and Guerrant(24) when even longer feeding periods were used, and confirming the earlier work of Adams and McCollum.(1)

To determine whether or not the calcium and phosphorus contents of the opihi supplements influenced the healing of rickets, as judged by the line test, 4 rachitic rats were fed a mixture of calcium and phosphorus salts ($CaCO_3$ and Na_2HPO_4) equivalent to the quantity of calcium and phosphorus found in 2 grams of opihi. In addition, opihi were ashed at dull red heat in an electric muffle and a quantity of the resulting ash equivalent to 2 grams of opihi was fed daily for 8 days to each

TABLE 6.—*Average quantities of ash and calcium in the femurs of rats used for the line test.*

Kind and quantity of daily supplement.	Number of rats.	Ash in fresh femurs.	Calcium in fresh femurs.	Calcium in ash of femurs.	Average gain in weight for 8 days.
		Per cent.	*Per cent.*	*Per cent.*	
Basal diet only (21 days)	6	14.0	5.0	35.8	
Basal diet only (29 days)	5	12.5	4.4	35.0	5
Cod-liver oil	5	15.3	5.5	35.6	2
Opihi, whole, 3 grams	10	11.9	4.2	35.2	17
Opihi, whole, 4 grams	5	13.4	4.7	35.0	14
Viscera without gonads 1 gram	7	13.5	[a] 4.6	[a] 35.2	11
Ovaries 1 gram	8	15.5	5.5	35.2	17
Testes 1 gram	6	17.3	6.3	36.1	16

[a] Average for 5 rats.

of 9 rachitic rats. Subjected to the line test, the tibias of these 13 rats showed no evidence of healing rickets and appeared quite like those of the negative controls.

The experiments here reported were completed two years before the publication of Coward's book,(9) but her method for evaluating the units of vitamin in an unknown by plotting the logarithms of the doses has been used.(9, pp. 116, 117) The number of rats fed the international standard for series B was not equal to the number fed the supplements, as Coward recommends. We used both 21- and 29-day negative controls from each litter. The remainder of the rats in each litter were divided, so that some received supplements of the standard and others the substance to be tested.

With the use of the method of Coward, referred to above, and the results of the daily feeding of 2 grams of opihi, the units of vitamin D per gram would be 0.35; on the basis of the 3 grams dose the value would be 0.29 unit of vitamin D per gram. It may be noted from Table 7 that the results of feeding 3 grams of opihi are similar in the two series.

The above vitamin D values for whole opihi were obtained by comparing the results for opihi-fed animals with the results for 22 rats fed 0.5 unit of the international standard or reference cod-liver oil daily for 8 days, and 10 rats fed 1 unit daily for 8 days. The average results for the standards were 2.1+ healing for those fed 0.5 unit and 3.7+ healing for those fed 1 unit. If more rats had been fed 1 unit daily the average healing would probably have been less than 3.7+. Bills et al.(5) have produced a curve based on the protocols of 4,000 rats to

TABLE 7.—*Summary of observed healing in rachitic rats of series A and B.*[a]

Supplements.		Series A.		Series B.	
Kind.	Quantity.	Number of rats.	Rating.	Number of rats.	Rating.
International Standard and reference cod-liver oil	0.5 unit	----------	----------	22	2.1+
	1 unit	----------	----------	10	3.7+
Opihi	1 gram	----------	----------	11	2.4+
	2 grams	3	2.3+	13	2.9+
	3 grams	10	3.2+	12	3.4+
	4 grams	12	3.8+	----------	----------
	5 grams	4	4.0+	----------	----------
Viscera, total soft parts	1 gram	----------	----------	11	3.9+
Viscera, without gonads	1 gram	28	3.2+	----------	----------
Ovaries	1 gram	12	3.9+	----------	----------
Testes	1 gram	10	3.9+	----------	----------

[a] Data obtained by adding the total number of plus signs for all the rats in each group and dividing by the number of rats in the group.

show the degree of healing when the dose of an antirachitic substance is increased by different multiples. According to their curve the expected healing for 1 unit of the international standard, based on our results for 0.5 unit, should be 3.2+ instead of 3.7+. Had more rats been fed 1 unit, doubtless a figure nearer to 3.2+ would have been obtained. If the theoretical figure of 3.2+ instead of 3.7+ is used as the healing value for 1 unit and the logarithms of the doses are plotted as recommended by Coward, the units of vitamin D per gram of whole opihi (based on the data for the rats fed 2 and 3 grams daily) would be 0.41 and 0.38 units instead of 0.35 and 0.29 units—increases of 17 and 31 per cent, respectively. However, as Bills et al.(5) have shown by statistical treatment of large quantities of data that the line test for vitamin D as carried out in their laboratory has a probable error of about 10 per cent when 20 rats are used for an assay, we can conservatively use the figure of 0.30 unit of vitamin D per gram or 30 units per 100 grams of whole opihi as an average figure.

This value is six times greater than that for other shellfish that have been investigated. Daniel and Munsell (1937) have assigned to oysters and clams values of 5 international units of vitamin D per 100 grams, although the original data on which their estimates are based have been obtained from experiments with but a small number of animals.(15, 26) Our analysis of opihi showed 1.7 per cent ether extract, which appeared as a dark-colored oil. If all the vitamin D were contained in the

oil it would have approximately 1,760 units per 100 grams, a value which is low compared with that of average cod-liver oil (10,000 units per 100 grams) and other fish oils.

Though no tests were made involving the use of the foot and mantle only, it is probable that they contain proportionately as little vitamin D as vitamin A, and that all or nearly all the vitamin D may be found in the viscera. Tests on viscera with and without gonads, and separate tests with ovaries and testes, indicate that they all contain about 4 times as much vitamin D per gram as whole opihi, and that the gonads contain somewhat more vitamin D than other parts of the viscera (intestinal tract and hepatopancreas).

Though babies in ancient Hawaii were sufficiently exposed to sunshine to insure an adequate supply of vitamin D, the feeding of the soft parts of opihi as one of their earliest foods assured them of an excellent source of vitamin A and a good source of additional vitamin D.

FOOD OF THE OPIHI

The problem of how marine animals acquire their vitamin A and vitamin D contents continued to be worthy of investigation. When the first series of experiments showed opihi to be a relatively good source of these two vitamins, it was thought that some answer to the question might be gained from a study of opihi in an aquarium where the feeding and other experimental conditions could be controlled. However, all efforts to raise or maintain opihi in the large salt-water aquarium of the University of Hawaii were unsuccessful, although all manner of tropical and semitropical fish have been kept there. It was thought, however, that a study of the food of the opihi might throw some light on the origin of their vitamin A and D contents. Marie C. Neal, Botanist at the Bernice P. Bishop Museum, Honolulu, was engaged to make an examination of the alimentary tract of 16 specimens of opihi chosen from a much larger collection of the shellfish from the islands of Molokai and Oahu. As soon as they were removed from the rocks to which they had been clinging, the opihi were placed in either alcohol or formalin to kill them instantly and check the digestion of food. Below is a brief summary of the report prepared by Miss Neal:[5]

[5] The details of the study are on file at the Bishop Museum and the University of Hawaii, Honolulu.

Whenever possible, samples for microscopic study were taken from three parts of the alimentary tract—stomach, intestine, and rectum. Scrapings from the outer surface of the opihi shells were also carefully examined. Perfect specimens of algæ from these scrapings were compared with the contents of the alimentary tract of the opihi, which contained minute fragments resulting from the rasping of the mollusk's radulæ over the growth of algæ on the rocks and from the disintegrating action of the digestive juices of the opihi on the ingested algæ.

As a result of careful microscopic examination of the shell scrapings and of the contents of the digestive tracts of the opihi, it is concluded that the animals graze on minute algæ and juvenile forms of small algæ growing on the rock surfaces where the opihi cling. The digestive tracts of the opihi examined contained the following algæ:[6] Myxophyceæ (blue-green algæ): *Hydrocoleum* sp., *Lyngbya* sp., *Microcoleus* sp., and undetermined genera and species; Chlorophyceæ (green algæ): *Cladophora* sp. and *Enteromorpha* sp.; Phæophyceæ (brown algæ): *Ralfsia* sp., and *Ectocarpus* sp.; Rhodophyceæ (red algæ): *Erythrotrichia* sp.; Bacillariaceæ (diatoms): many undetermined genera and species.

Many of the algæ found in the digestive tracts are similar to those growing on the outer surface of the shells of the opihi. The most abundant algæ in the habitat of the opihi seemed to be forms of minute blue-greens, which grow as small tufts of filaments or soft gelatinous layers of colonies, some including much lime. Apparently the lime was not consumed, whereas the algæ were. The two green algæ and *Ectocarpus* sp. were eaten in extremely juvenile states, presumably shortly after germination. The two green algæ, the red alga, and *Ectocarpus* sp., all filamentous forms, were easily digested. The brown alga, *Ralfsia* sp., which forms flat crusts of closely associated filaments on rocks, was well digested.

In another investigation of algæ on the reefs of Oahu, diatoms have been found, alone and in colonies, almost invariably present in fine material scraped from rocks, mixed with sand, silt, and small algæ. Owing to their small size, diatoms can easily be taken into the mouths of opihi, both in colonies and with larger plants, and can then pass through the alimentary tracts. Their

[6] Thanks are due Mr. C. C. Jao, National Research Institute of Biology, Academia Sinica, Nanking, China, for assistance in determining the genera of the algæ.

siliceous shells are apparently impervious to digestive juices, but the IKI test for detection of protein, applied to opihi fæces containing diatoms, showed that the protoplasmic contents of the diatoms were lacking. Possibly the protoplasm was extracted by enzyme action. The gelatinous matter joining diatoms in colonies may also be food for the opihi. The small amount of diatoms, compared with the large amount of other algal forms present in the alimentary tract, as well as the minuteness of diatoms, indicate that the latter are a minor source of the food of opihi.

Whether or not the opihi obtain their vitamin D from their food or whether they synthesize it could perhaps be determined by a protracted and thorough study of the algæ and diatoms on which they feed. The opihi crawl about the racks and are often exposed to bright sunlight; the edge of the mantle extends beyond the shell, and certainly must come in contact with the sun's rays. Reflected rays from the rocks must also reach the foot. Much of the food of the opihi, although washed by the waves, is at least intermittently exposed to sunshine. Despite the low fat content of opihi, revealed by chemical analysis, one might anticipate a greater vitamin D content than the assay shows to be present. On the other hand, the vitamin A activity of the opihi, due either to some precursers or to vitamin A itself or to both, must come originally from the algæ consumed by the opihi.

Copping,(8) who has studied the vitamin D content of dried copepod material, has also reviewed the work of others who have studied the vitamin A and D contents of zoö- and phytoplankton. The results of all previous work seem to establish the fact that zoö- and phytoplankton are better sources of vitamin A than of vitamin D.

The relatively lower vitamin D than vitamin A content of opihi would suggest the inability of the opihi to synthesize vitamin D, or might reflect merely the proportionate quantities of these two vitamins which may occur in their food.

REPRODUCTION

An effort was made to determine whether or not the breeding season of the opihi was confined to certain periods of the year, as it was believed that the quantity of gonad tissue present would probably affect the vitamin A and D content of the

whole opihi. During a period of 12 months, 161 shellfish were carefully weighed to determine the percentage weight of gonads in relation to the weight of the whole edible opihi. The relative weight of gonads was greatest during October, November, and December (about 15 per cent), and smallest during May, June, and July (about 7 per cent) for the year studied, the average gonad weight for the year being 11 per cent of the total body weight. Many more samples would have to be weighed each month over a period of years to determine if this variation in weight of gonads occurs regularly. Microscopic examination of a large number of testes and ovaries showed mature reproductive cells (ova or spermatids) to occur in variable numbers, but they were always present during all seasons of the year.

SUMMARY

1. The opihi, or Hawaiian limpet (*Helcioniscus exaratus* Nuttall and *H. argentatus* Sowerby), has been analyzed for moisture, protein, ether extract, total ash, calcium, phosphorus, iron, copper, silicon, and glycogen. Separate analyses have been made of the solid portion (foot and mantle) and of the viscera. Moisture, protein, ether extract, and total ash have been determined for the ovaries and for the testes. Opihi are a good dietary source of protein, calcium, and iron.

2. Experiments with anæmic rats showed that the feeding of opihi, which are low in copper, did not result in any marked regeneration of hæmoglobin until this mineral was added.

3. Whole fresh opihi contain, per 100 grams, approximate quantities of the vitamins as follows: 4,000 international units of vitamin A, 130 Sherman-Bourquin units of vitamin B_2 (G) (300 γ flavin), and 30 international units of vitamin D. They contain little or no vitamin B_1 and are devoid of vitamin C.

4. A study of the contents of the digestive tracts of the opihi showed that their food consists largely of blue-green and other algæ, and that diatoms, although present, are probably a relatively unimportant food source.

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ILLUSTRATIONS

PLATE 1. HELEIONISCUS SP.

FIG. 1. Dorsal aspect of shell; *2*, ventral aspect; *3*, dorsal aspect after removal from shell; *4*, digestive organs lifted to show testis—large light-colored mass; *5*, digestive organs lifted to show dark-colored ovary below.

TEXT FIGURE

FIG. 1. Average gain in weight of groups of young rats fed opihi and the international standard carotene. The quantities indicated were feed weekly. The numbers in parentheses show the number of rats used for each test.

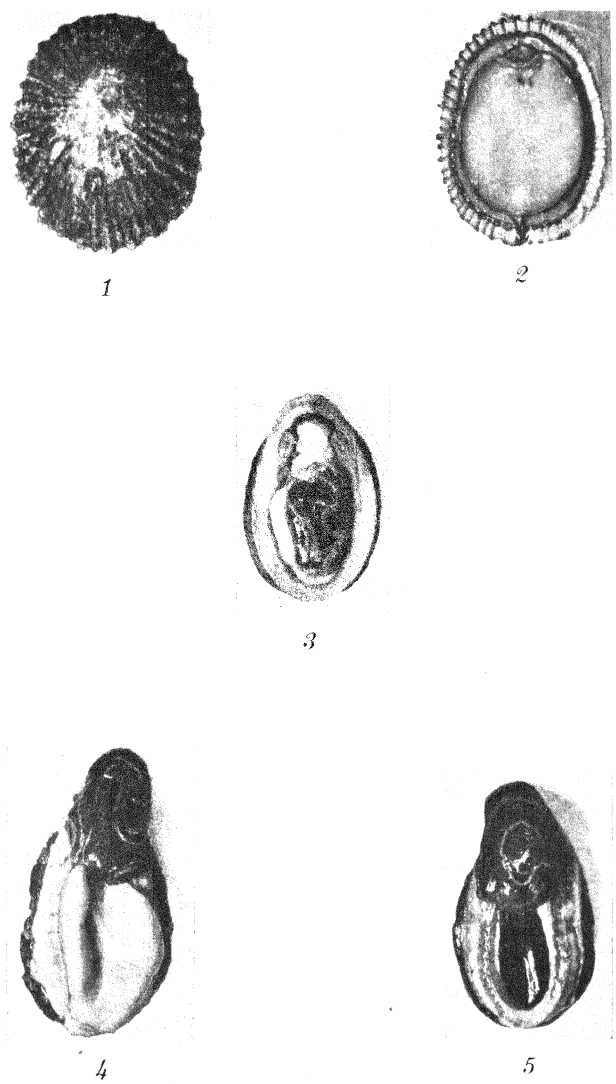

PLATE 1. HELEIONISCUS SP.

A NEW GOBIOID FISH FROM LUZON

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Manila*

ONE PLATE

APARRIUS SABAGENSIS sp. nov.

Dorsals VI, I-10; anal I, 9; pectorals, 20; caudal, 22; 46 to 49 scales in longitudinal series, 13 scales in transverse series, 16 scales before first dorsal.

Head low, narrower than body, 5.5 times in total length and equal to caudal; snout slightly convex, 4 times in head; eyes high, dorsolateral, equal to snout; pupil white, equal to snout; interorbital space narrow, 0.67 diameter of eye; mouth small, oblique, upper and lower jaws equal in length; posterior angle of maxillary under anterior third of eye or below anterior part of pupil; teeth microscopic, two rows above and three rows below, with a pair of small outward canines in outer jaw; tongue short, slightly notched, adnate to tip; head and opercles naked.

Body elongate, laterally compressed; depth 5 times in total length; dorsal outline slightly arched; trunk with ctenoid scales, breast, nape, and pectoral base with small cycloid scales; pores absent on anterior and posterior part of interorbital space. Depth of caudal peduncle twice in head; caudal pointed.

Dorsals well separated, their height a little more than 0.66 depth of body. Second dorsal spine slightly elongated, thread-like; posterior ray of second dorsal short, not reaching caudal; pectorals and pelvic pointed, equal in length.

Alcoholic specimens pale yellow to white, with transverse irregular dark specks on scales on lateral sides of body; or a pigmented blackish spot below eye; a blackish spot on pectoral base; first dorsal spines alternately black-spotted; membranes of first dorsal with three to five rows of dark bands; second dorsals with three or four rows of dark spots; anal colorless; live specimens transparent yellowish.

Here described froom 30 specimens, one type specimen, Cat. No. 41994, and cotypes, 29 to 58 mm long, collected from Cagayan River, barrio Catayaoan, Lallo, Cagayan Province, January 31, 1939, and deposited in the ichthyological collection of

the Division of Fisheries of the Department of Agriculture and Commerce.

Table 1 shows a comparative study of the external characters of the species of the genus *Aparrius*.

TABLE 1.—*External characters of species of Aparrius.*

Species.	Distribution.	Scales in longitudinal series.	Scales in transverse series.	Body pigmentation.	Caudal.
A. acutipinis	Abra River, Cauayan	26–29	7–8	No black longitudinal bands on side.	Sharply pointed, longer than head.
A. moloanus	Molo, Panay Island	38–42	13–14	Two black longitudinal bands on side.	Not acutely pointed, as long as head.
A. aurocingulus	Ovalau Islands; Fiji Islands	56	18–20	With spots and blotches of light brown and golden.	Similar to *A. acutipinis.*
A. sabagensis	Catayaoan, Lal-lo, Cagayan, Luzon.	46–49	13	Transverse irregular bands.	Similar to *A. moloanus.*

Aparrius sabagensis is close to *A. moloanus* in the number of dorsal and anal spines and shape of caudal, but differs from the latter in the greater number of scales in the longitudinal series, and in the smaller number of scales in the transverse series. It also differs remarkably in pigmentation. The adult goby is named *sabag* in Ibanag. It is undoubtedly another source of *ipon* (goby fry) of the Cagayan River.

Measurements.—Total length, 71 mm; standard length, 58; length of head, 13; width of head, 7; width of mouth, 4; width of gill opening, 8; depth of body at anal origin, 14; width of body, 6; length of pectoral, 8; width of pectoral base, 5; length of ventral, 8; width of ventral, 4; length of caudal, 13; snout to origin of first dorsal, 19; snout to origin of anal, 30; lower jaw to chin, 5.

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ILLUSTRATION

[Drawn by Nemesio Dimanlig, Jr.]

PLATE 1. *Aparrius sabagensis* sp. nov.

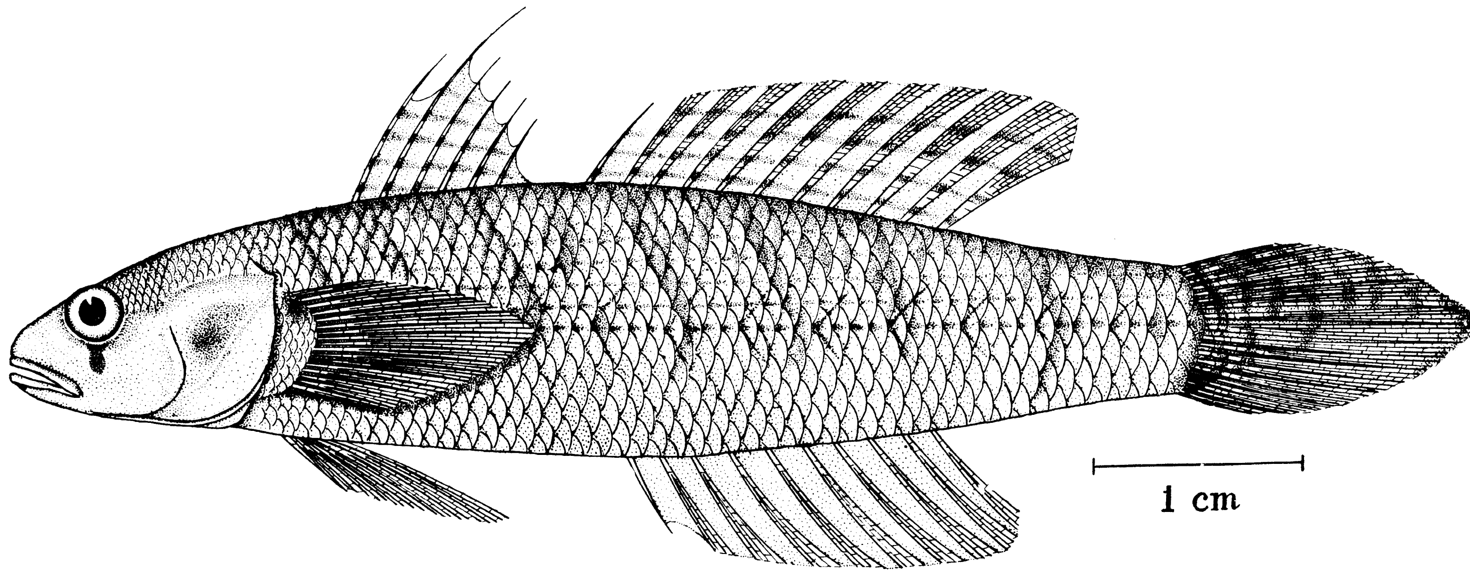

PLATE 1. APARRIUS SABAGENSIS SP. NOV.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XLII[1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

FOUR PLATES

The exceptionally interesting crane flies described at this time were taken at various stations on Mount Omei, Szechwan, western China, by Mr. Tsen Bao-chi. Mr. Tsen undertook the present trip during late May and early June, 1938, acting under the direction and guidance of the Reverend Mr. George Meredith Franck. In late May, great masses of snow still persisted at the higher altitudes on the mountain, and the relatively few species of Tipuloidea taken were virtually all winter and early spring forms, including no fewer than 8 species of Trichoceridæ. By mid-June at the summit, and progressively earlier at the various temples lower down the mountain (White Cloud, 9,000 feet; Chu Lao Tong, 6,500 feet; Flying Bridges, 3,000 feet), numerous Tipulidæ of the spring fauna were on the wing. I am greatly indebted to Mr. Franck and to Mr. Tsen for their further efforts to make known the rich tipulid fauna of Mount Omei. It may be noted that already some 325 species of crane flies have been secured at various altitudes on Mount Omei. In the present paper the recording of the genus *Lipsothrix* Loew adds another element to the unsually long list of genera and subgenera in the Chinese fauna.

TIPULINÆ

TIPULA (NIPPOTIPULA) BREVIFUSA sp. nov. Plate 1, fig. 1.

Mesonotum dark brown, lateral portions light yellow; nasus lacking; antennæ with pedicel clear orange, flagellum black; femora obscure yellow, with a narrow, dark-brown, subterminal ring; tibiæ and tarsi black; wings with ground color strongly infumed, conspicuously patterned with dark brown and whitish subhyaline; m-cu at or just before midlength of M_{3+4}, the ap-

[1] Contribution from the entomological laboratory, Massachusetts State College.

parent mediocubital fusion thus relatively short; abdomen reddish yellow, outer segments uniformly brownish black.

Male.—Length, about 35 to 36 millimeters; wing, 23 to 24; antenna, about 6 to 6.5.

Frontal prolongation of head yellowish gray above, blackened on sides, nasus lacking; palpi black. Antennæ with scape brown, pedicel clear orange, flagellum black; flagellar segments short, basal enlargement only moderately developed; verticils much longer than segments. Front and anterior orbits light yellow, posterior orbits more brownish yellow; center of vertex and occiput with a dark-brown median line.

Pronotum dark brown medially, yellow on sides. Lateral border of præscutum and dorsopleural membrane light yellow, contrasting with the dark-brown remainder of notum; median line of scutum narrowly pale. Pleura variegated dark brown and pale, dorsal pleurites darker than ventral pleurites, narrowly lined longitudinally with pale, including a more silvery area on ventral pleurotergite; meral region pale. Halteres with stem reddish brown, base of small knob dark brown, apex reddened. Legs relatively short and stout; coxæ pale brown, tips paler, posterior pair more uniformly darkened; trochanters testaceous brown; femora obscure yellow, with a narrow dark-brown ring before subequal pale apex; tibiæ and tarsi black, tibial bases restrictedly pale. Wings (Plate 1, fig. 1) with ground color strongly infumed, clear yellowish in costal region; a conspicuous dark-brown and whitish subhyaline pattern, as follows: Dark area at arculus, continued outwardly to wing margin as a broad seam along vein Cu, somewhat more expanded into cell M at near midlength of vein; a small cloud at origin of Rs; stigma darker, involving also the anterior cord, enclosing a small pale area just above fork of Rs; small marginal darkenings at ends of veins R_{4+5} to 2d A, these diffuse and more or less confluent at margin though variegated by small cream-colored droplets at ends of cells; whitish subhyaline areas chiefly in radial field, before and beyond origin of Rs, and poststigmal in outer radial cells; a narrow obliterative streak along posterior edge of cell 1st M_2; veins brownish yellow, darker in clouded portions. Venation: Rs more than twice as long as m-cu, the latter at or just before midlength of M_{3+4}.

Abdomen relatively long, reddish yellow, tergites more darkened sublaterally, becoming more extensively so on outer segments, hypopygium and preceding segments uniformly dark-

ened; lateral borders of tergites narrowly buffy. Hypopygium large, massive.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*). Paratopotype, male.

Tipula (*Nippotipula*) *brevifusa* is quite distinct from its two closest allies, *T.* (*N.*) *anastomosa* Edwards, of the Federated Malay States, and *T.* (*N.*) *pulcherrima* Brunetti, of the Himalayan Region. It differs especially in the coloration of the wings and in the venation, notably the distal position of m-cu which gives the impression of a short mediocubital fusion.

TIPULA (VESTIPLEX) ERECTILOBA sp. nov. Plate 1, fig. 2; Plate 2, figs. 25 and 26.

General coloration of head and thorax gray; antennæ (male) very short, 12-segmented; mesonotal præscutum with three darker gray stripes; halteres elongate, obscure yellow, knobs weakly darkened; legs brownish black to black; wings fulvous brown, variegated with darker brown and yellowish-white areas, the latter including major markings across base of cell 1st M_2 and at near two-thirds length of cell M; inner end of cell 1st M_2 pointed; basal abdominal segments reddish brown, tergites narrowly bordered laterally with black, outer segments uniformly darkened; male hypopygium with tergite a partly blackened saucer, cephalic portion elevated into an erect median lobe; caudal border of tergite with a linear median split; inner dististyle unusually broad and simple, its beak reduced to a small triangular point.

Male.—Length, about 14 to 17 millimeters; wing, 18.5 to 22.5; antenna, about 2.3 to 2.6.

Frontal prolongation of head relatively long, black, sparsely pruinose; nasus lacking or very short and stout; palpi black. Antennæ unusually short, only a little longer than head; scape and pedicel black; basal segments of flagellum brown or weakly bicolored, obscure yellow, darker at base, outer segments passing into brownish black; in cases antennæ uniformly black; basal flagellar segment cylindrical, nearly twice as long as second; second and succeeding segments short-cylindrical, without an evident basal enlargement; verticils short, subequal in length to segments; antennæ apparently only 12-segmented, usual thirteenth segment fused with penultimate. Head brownish gray, anterior orbits broadly light gray.

Pronotum dark brown, sparsely pruinose. Mesonotal præscutum light gray, lateral margins conspicuously darkened, disc

with three darker gray stripes, lateral pair poorly differentiated against ground; median stripe very broad in front, tapering rapidly behind, posterior end more or less split, in cases posterior interspaces with narrow dark lines before suture; scutal lobes light gray, variegated with darker gray; posterior sclerites of notum gray. Pleura dark gray. Halteres unusually long, about one and one-third as long as antennæ, obscure yellow, knobs weakly darkened. Legs with coxæ and trochanters gray; femora and tibiæ uniformly black; tarsi black or brownish black; claws simple. Wings (Plate 1, fig. 2) with a fulvous brown ground, variegated with darker brown and yellowish-white areas, the former including clouds at origin of Rs, cord, and as seams along vein 2d A and outer portion of Cu; the most conspicuous subhyaline areas lie across the cord and at near two-thirds length of cell M, the latter preceded and followed by pale-brown clouds; a similar dusky wash in cell R between arculus and origin of Rs; cell C clouded; clear yellow areas before and beyond stigma; veins brown, more yellow in costal areas. Venation: R_{1+2} preserved; m and petiole of cell M_1 subequal; inner end of cell 1st M_2 pointed.

Basal segments of abdomen reddish brown, tergites narrowly bordered by black; sternites similar, posterior borders narrowly darkened; sixth and succeeding segments blackened, pruinose. Male hypopygium (Plate 2, fig. 25) relatively small and simple. Ninth tergite (Plate 2, fig. 26, 9*t*) with posterior half modified into a partly blackened saucer, as often occurs in the subgenus, but its structure quite distinct from that of other regional species; caudal margin of saucer heavily blackened, with a very narrow, parallel-sided median notch, lobes adjoining this median split microscopically roughened and with numerous small punctures; posterior portion of saucer yellow, only feebly chitinized except for a broad median strip which extends cephalad to form back wall of plate in restricted median portion only; viewed from the side (Plate 2, fig. 25, 9*t*) this narrow plate juts conspicuously above the level of the remainder of tergite as an erect lobe; posterior portion of tergite behind saucer divided medially by pale membrane, almost without punctures. Basistyle unarmed. Outer dististyle, *od*, a long-oval, flattened lobe, its apex obtuse. Inner dististyle, *id*, unusually broad and simple, the usual beak reduced to a small triangular point. Eighth sternite, 8*s*, unarmed.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, summit, altitude 11,000 feet, May 26, 1938 (*Tsen*). Paratopotypes, 12 males.

Tipula (*Vestiplex*) *erectiloba* is very different from all other regional species of the subgenus, differing especially in the very short antennæ, elongate halteres, wing pattern, and especially the structure of the male hypopygium.

TIPULA (VESTIPLEX) FACTIOSA sp. nov. Plate 1, fig. 3; Plate 2, figs. 27 and 28.

Allied to *deserrata;* antennæ relatively short, flagellum black; mesonotal præscutum olive-gray, with four brown stripes that are more or less completely bordered by darker; posterior sclerites of notum with a capillary dark line; femora obscure yellow, tips narrowly blackened; tibiæ and tarsi black; claws (male) toothed; wings narrow, with long basal petiole, grayish brown, variegated with darker brown and subhyaline areas; cell 2d A relatively narrow; basal four abdominal segments yellow, trivittate with brownish black, outer segments blackened; male hypopygium with tergite completely divided medially, adjoining mesal-apical lobes narrow, their inner margins conspicuously serrulate; basistyle with an unusually powerful black spine; inner dististyle a broadly flattened disc, rostral portion long and slender.

Male.—Length, about 15 to 16 millimeters; wing, 17 to 20.5; antenna, about 2.8 to 3.

Frontal prolongation of head brownish yellow; nasus very long; palpi dark brown. Antennæ relatively short, only a little longer than palpi; scape and pedicel yellow, flagellum black; flagellar segments subcylindrical, not or only slightly incised, basal swelling small; verticils subequal in length to segments. Head brownish gray, anterior vertex and posterior orbits more buffy; central portion of posterior vertex with a brownish median stripe.

Pronotum olive-gray, variegated with darker. Mesonotal præscutum olive-gray, with four brown stripes, intermediate pair separated by a pale line that is narrowly bordered by darker brown, lateral stripes similarly bordered; scutum buffy yellow, variegated with brown; scutellum testaceous; mediotergite olive-gray; a nearly continuous capillary brown line extending from suture to abdomen. Pleura yellow, variegated with more grayish areas on ventral anepisternum and ventral sternopleurite. Halteres with stem obscure yellow, base of knob blackened, apex

pale. Legs with coxæ greenish yellow; trochanters yellow; femora obscure yellow, brighter at base, tips narrowly blackened; tibiæ and tarsi black; claws (male) with basal tooth. Wings (Plate 1, fig. 3) relatively narrow, prearcular field long and narrow; grayish brown, variegated with slightly darker brown and subhyaline areas; cell C uniformly yellow, Sc slightly more darkened except at outer end; stigma dark brown; paler brown clouds at origin of Rs, cord, outer end of cells R_2 and R_3, beyond midlength of cell M, and postarcular in bases of cells R and M; the major subhyaline areas occur before and beyond the cord, postarcular in both cells R and M, before outer end of cell M, and in axillary region; smaller pale areas in outer ends of cells 1st A and 2d A; veins dark. In the female the dark pattern is somewhat heavier and more contrasted. Venation: R_{1+2} entire; m subequal to petiole of cell M_1; Rs from two to two and one-half times m-cu; cell 2d A relatively narrow.

Abdomen with basal four tergites yellow, with three conspicuous brown to brownish-black lines, sublateral stripes narrower than buffy margins; median stripe broader; fifth and succeeding segments more uniformly blackened, lateral borders of more basal segments pale; basal sternites pale, outer segments darkened. Genital shield of female black; cerci elongate, deep, with smooth margins. Male hypopygium with ninth tergite (Plate 2, fig. 27, *9t*) completely divided on midline by pale membrane, mesal-apical angles produced into narrow blackened lobes, their inner margins conspicuously serrulate. Basistyle (Plate 2, fig. 28, *b*) with an unusually strong and powerful black spine, directed chiefly dorsad. Outer dististyle, *od*, a flattened clavate lobe provided with numerous setæ. Inner dististyle, *id*, with a long slender beak; posterior portion of style a flattened obtuse disc, with scattered setæ. Eighth sternite extensive, margin without armature.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*). Allotopotype, female. Paratopotypes, 3 males; paratype, male, Kwanhsien, altitude 2,000 feet, May, 1933 (*Graham*).

Most closely related to *Tipula* (*Vestiplex*) *deserrata* Alexander, agreeing in the strongly spined basistyle and in the ninth tergite being entirely divided medially by a pale membrane, with the adjacent lobes heavily blackened and serrulate. It differs especially in several features of the male hypopygium, especially

of the tergite, basistyle, and dististyles. I am placing these species in *Vestiplex* despite the nonserrated cerci. A further discussion of Indo-Chinese species of *Tipula* on the borderline between *Vestiplex* and *Oreomyza* has been published elsewhere.[2]

TIPULA (OREOMYZA) STERNOSETOSA sp. nov. Plate 1, fig. 4; Plate 2, figs. 29 and 30.

General coloration buffy gray, præscutum with four darker brownish-gray stripes; antennæ with scape and pedicel yellow, flagellum black; frontal prolongation of head above light yellow; apex of knob of haltere yellow; femora black, obscure yellow at base, with a conspicuous obscure yellow subterminal ring; tibiæ black; wings brown, variegated with yellow; R_{1+2} entire, m-cu shortly before fork of M_{3+4}; abdominal tergites yellow, trivittate with black, median stripe broad and continuous, outer segments blackened; male hypopygium with outer dististyle unusually long and slender, black; basistyle on mesal face produced caudad into a strong blackened rod; eighth sternite with numerous, very long, erect, pale setæ.

Male.—Length, about 13 millimeters; wing, 15; antenna, about 4.

Female.—Length, about 17 to 18 millimeters; wing, 16 to 16.5.

Frontal prolongation of head light yellow above, slightly darker on sides; nasus distinct. Antennæ of moderate length; scape and pedicel light yellow, flagellum black; flagellar segments subcylindrical, very feebly incised, basal swellings correspondingly small; longest verticils a little shorter than segments; terminal segment small, thimble-shaped. Head buffy yellow, central portion of vertex weakly darkened.

Pronotum buffy, with a narrow brown median mark. Mesonotal præscutum buffy gray, with four darker brownish-gray stripes that are very indistinctly margined with darker; setigerous punctures pale and inconspicuous; posterior sclerites of notum gray, each scutal lobe with two darker areas; scutellum and mediotergite with a capillary darkened median line. Pleura gray. Halteres with stem yellow, knob dark brown basally, apex broadly yellow. Legs with coxæ gray; trochanters yellow; femora obscure yellow at base, more broadly so on forelegs, narrower on posterior femora; beyond base ground color black, with a narrow, obscure, yellow, subterminal ring before broader black tips; tibiæ and basitarsi black, terminal tarsal segments somewhat paler; claws (male) with an erect spine. Wings

[2] Philip. Journ. Sci. 57 (1935) 118, 119.

(Plate 1, fig. 4) brown, handsomely patterned with pale yellow; prearcular and costal fields deeper yellow; chief yellow areas as follows: a major area beyond postarcular darkening, in both cells R and M; before and beyond stigma; near outer end of cell M; across base of cell 1st M_2; basal portion of Cu and in anal cells; cell 2d A uniformly yellow with exception of a large marginal cloud at near midlength; veins pale brown, more yellowish in brightened areas. In the female the yellow areas are even more extensive. Venation: R_{1+2} entire; m-cu shortly before fork of M_{3+4}.

Abdominal tergites yellow, with a broad, continuous, blackened, median stripe and somewhat narrower sublateral stripes that are interrupted at posterior margins of segments; lateral borders of tergites gray; sternites yellow with a median dark line; outer abdominal segments passing into black. Male hypopygium (Plate 2, fig. 29) with ninth tergite, *9t*, fused with sternite, *9s*, on its cephalic portion; basistyle, *b*, with suture complete but pale and membranous on dorsal portion; apex of basistyle slightly produced. Ninth tergite (Plate 2, fig. 30, *9t*) with caudal margin evenly concave, lateral lobes blackened but relatively small and low, ventrad of these lobes with further chitinized extensions; ventral surface of tergite with transverse arms that meet in middle to form an obtuse median lobe. Basistyle, *b*, on mesal face with a strong blackened rod. Outer dististyle, *od*, subequal in length to latter, unusually long and slender, dark-colored, provided with long setæ that are chiefly unilateral in distribution except at tip. Inner dististyle, *id*, with rostral beak stout; posterior angle of style produced into a conspicuous rounded lobe. Eighth sternite, *8s*, unarmed, ventral surface with numerous, very long, erect, pale setæ (the punctures indicated in the figure).

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, June 17, 1938 (*Tsen*). Allotopotype, female. Paratopotype, female.

Tipula (*Oreomyza*) *sternosetosa* is generally similar to species such as *T.* (*O.*) *percommoda* Alexander, differing in many characters, as the yellow frontal prolongation of head, yellow femoral ring, and especially the structure of the male hypopygium, as the tergite outer dististyle, sclerotized rod of the basistyle, and the conspicuous vestiture of the eighth sternite.

TIPULA (OREOMYZA) INCISURATA sp. nov. Plate 1, fig. 5; Plate 2, figs. 31 and 32.

General coloration light gray, præscutum with four entire, more brownish stripes; antennæ relatively long, if bent backward extending to some distance beyond base of abdomen; scape and pedicel yellow, flagellum black, verticils shorter than segments; wings strongly infumed, variegated with yellow and cream-colored areas; R_{1+2} entire, Rs long; basal abdominal segments reddish yellow, narrowly trivittate with brownish black; outer abdominal segments, including hypopygium, black; male hypopygium with caudal margin of tergite with a small but deep median notch, on dorsal surface this continued cephalad as a deep median furrow for almost length of sclerite; lateral tergal lobes broad, obliquely truncated, outer lateral angles obtuse.

Male.—Length, about 14 millimeters; wing, 15; antenna, about 6.

Frontal prolongation of head black, sparsely pruinose; nasus reduced to a small lobe; palpi black. Antennæ (male) relatively long, if bent backward extending to some distance beyond base of abdomen; scape and pedicel yellow, flagellum black, first segment restrictedly brightened at base; flagellar segments moderately incised, verticils unilaterally distributed, shorter than segments, all arising from the small basal enlargement. Head yellowish gray, orbits narrowly lined with clearer gray; posterior orbits narrowly bordered internally by lines of darker brownish gray; vertical tubercle very low.

Pronotum gray, variegated with darker. Mesonotum light gray, with four entire, more brownish stripes, median interspace obscured; scutal lobes darkened; posterior sclerites of notum light gray, each with a central darker area. Pleura gray, variegated with darker gray, especially on ventral sternopleurite and meron; dorsopleural membrane dark buffy. Halteres relatively long, stem obscure yellow, knob darkened. Legs with coxæ gray; trochanters yellow; remainder of legs black, femoral bases restrictedly light yellow; femora with faintest possible indication of a more brightened subterminal ring; claws (male) with erect basal tooth. Wings (Plate 1, fig. 5) with ground color strongly infumed, variegated with more yellowish and creamy-white areas; cell Sc and most of prearcular field yellow; stigma brown, slightly darker than ground; the chief yellow areas are in bases of cells R and M, at near two-thirds length of M, immediately before origin of Rs, in outer end of

cell R, and poststigmal; smaller pale areas in cells Cu and 1st A; a more creamy-white area crosses cell 1st M_2 into base of cell M_3; veins dark, paler in brightened areas, especially obliterative ones at cord. Venation: R_{1+2} entire, straight; Rs long, about two and one-half times m-cu; petiole of cell M_1 a little less than m.

Basal abdominal tergite pruinose basally; succeeding segments reddish yellow, narrowly trivittate with brownish black; fifth and succeeding segments, including hypopygium, passing into black. Male hypopygium (Plate 2, fig. 31) with the basistyle, *b*, entire, not produced, provided with long yellow setæ. Ninth tergite (Plate 2, fig. 32, 9*t*) with a small but deep rectangular median incision, from base of which a long furrow on dorsal surface continues cephalad for almost the entire length of the sclerite; lateral tergal lobes broad, obliquely truncated, outer lateral angles obtuse; surface of tergite with numerous black setæ, marginal setæ small and slender. Outer dististyle narrow, pale, with conspicuous setæ. Inner dististyle, *id*, with beak and a lobe beneath it heavily blackened. From base of ninth sternite on midline a small erect lobe juts ventrad. Eighth sternite narrow, simple.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, June 6, 1938 (*Tsen*). Paratopotype, male.

Tipula (*Oreomyza*) *incisurata* is quite different from all other regional species, especially in the structure of the male hypopygium, but likewise in the antennæ and in the pattern of the wings. Superficially it somewhat resembles other species of the genus belonging to various subgenera, as *T.* (*Vestiplex*) *inquinata* Alexander, *T.* (*Acutipula*) *omeiensis* Alexander, and *T.* (*Oreomyza*) *sex-lobata* Alexander.

TIPULA (OREOMYZA) INTERRITA Alexander.

Female.—Length, about 30 millimeters; wing, 9.5 by 1.3.

Characters as in male, differing most evidently in semi-atrophied wings. Nasus reduced. Antennæ 13-segmented, terminal segment small and closely applied to the penultimate. All tibiæ dirty brownish yellow, contrasting conspicuously with brownish-black femora. Wings reduced, as shown by measurements, venation correspondingly distorted; general coloration obscure yellow, stigmal region slightly more darkened; veins pale. Ovipositor with cerci very long and slender, straight,

with smooth margins; hypovalvæ much shorter and deeper, tips obtusely rounded.

Allotype, female, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, May 26, 1938 (*Tsen*).

Two further males are from the summit of Omei, altitude 11,000 feet, May 26, 1938 (*Tsen*).

CYLINDROTOMINÆ

LIOGMA SIMPLICICORNIS sp. nov. Plate 1, fig. 6; Plate 3, figs. 33 and 34.

General coloration polished black, dorsopleural membrane conspicuously yellow; antennæ black throughout, flagellar segments only moderately produced; halteres long, knobs infuscated; femora obscure yellow, passing through brown to brownish black; wings strongly suffused with brown, small stigma darker brown; r-m present; male hypopygium with dististyle narrowed on apical third, apex cultriform; gonapophyses appearing as narrowly expanded blades, surface at apex microscopically roughened.

Male.—Length, about 12 millimeters; wing, 9.5; antenna, about 3.4.

Rostrum and palpi black. Antennæ (Plate 3, fig. 33) black throughout; flagellar segments only moderately produced. Head polished black; anterior vertex a little wider than diameter of scape.

Pronotum black, posterior portion and dorsopleural membrane yellow. Mesonotal præscutum and scutum shiny black, surface smooth; scutellum pale, parascutella blackened; mediotergite black, sparsely pruinose. Pleura black, sparsely pruinose. Halteres relatively long and slender; stem dusky, yellow at base, knob infuscated. Legs with coxæ black; trochanters yellow; femora obscure yellow basally, passing into brown, tips brownish black; tibiæ brown, tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 6) with a rather strong brown suffusion; stigma small, oval, darker brown; veins brown. Venation: Sc long, extending to beyond level of r-m, tip pale to atrophied; r-m present; m-cu shortly beyond fork of M.

Abdomen elongate, black, pleural membrane and incisures restrictedly paler; hypopygium black. Male hypopygium (Plate 3, fig. 34) with dististyle, *d*, narrowed on apical third, apex cultriform. Gonapophyses, *g*, appearing as narrowly expanded blades, surface at apex microscopically roughened; inner edge of stem with several strong setæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, May 25, 1938 (*Tsen*).

Liogma simplicicornis is quite distinct from the other eastern Asiatic species of the genus in the reduced pectinations of the antennæ, which here approach the normal unmodified condition found in the related *Phalacrocera.* Whether it will be possible to maintain as full genera such groups as *Liogma, Triogma,* and *Phalacrocera* seems questionable to me.

LIMONIINÆ

LIMONIINI

LIMONIA (DICRANOMYIA) AMPLIFICATA sp. nov. Plate 1, fig. 7; Plate 3, fig. 35.

Large (wing, male, over 8 millimeters); general coloration of thorax medium brown; halteres pale yellow throughout; femora obscure yellow, tips darker; wings broad, whitish subhyaline, stigma and seams at cord and outer end of cell 1st M_2 weakly darkened; Sc_2 not far from tip of Sc_1; male hypopygium with a single long rostral spine on ventral dististyle, this arising from a low hemispherical blackened tubercle placed before midlength of prolongation.

Male.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum brown, moderately long, about one-half remainder of head; palpi black. Antennæ brownish black; flagellar segments oval, incisures well-defined; terminal segment about one and one-half as long as penultimate. Head dark brown; anterior vertex narrow.

Pronotum dark brown. Mesonotum almost uniform medium brown, without markings; præscutal setæ black, conspicuous. Pleura medium brown, dorsopleural region darker. Halteres pale yellow throughout. Legs relatively short and stout; coxæ pale brown; trochanters pale yellow; femora obscure yellow, tips darker; remainder of legs brownish testaceous, outer tarsal segments darker; claws long, with a conspicuous basal spine; terminal tarsal segment with modified flattened setæ at base. Wings (Plate 1, fig. 7) broad, whitish subhyaline, stigma slightly darker; cord and outer end of cell 1st M_2 a trifle seamed with darker; veins brown, more yellowish in prearcular and costal fields. Venation: Sc_1 ending opposite origin of Rs, Sc_2 near its tip; free tip of Sc_2 lying shortly proximad of R_2; cell 1st M_2 large, about equal in length to vein M_{1+2} beyond it; m-cu at fork of M.

Abdomen brown, vaguely patterned with paler, especially on basal sternites; hypopygium dark, ventral dististyle whitened. Male hypopygium (Plate 3, fig. 35) with caudal margin of ninth tergite, *9t*, emarginate, lobes broadly rounded. Basistyle, *b*, with ventromesal lobe extensive, provided with numerous long yellow setæ. Dorsal dististyle a powerful, angularly bent rod, its apex a long blackened spine. Ventral dististyle, *vd*, smaller in extent than basistyle, rostral prolongation well set off by a slightly constricted neck; prolongation heavily blackened, especially at pointed apex and along lower or cephalic margin; a single rostral spine, arising from a low hemispherical black tubercle placed before midlength of prolongation; spine black, elongate, subequal in length to rostrum. Gonapophysis, *g*, with mesal-apical lobe a slender, curved, blackened spine.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, June 6, 1938 (*Tsen*).

Limonia (*Dicranomyia*) *amplificata* is very distinct from the other species of the subgenus so far described. From the other forms having a single rostral spine on the ventral dististyle of the male hypopygium it is readily told by the large size and details of structure of the male hypopygium. The most similar described species is *L.* (*D.*) *montium* Alexander, of the high mountains of Formosa.

LIMONIA (GERANOMYIA) OBESISTYLA sp. nov. Plate 1, fig. 8; Plate 3, fig. 36.

General coloration plumbeous brown, præscutum with three poorly indicated darker-brown stripes; rostrum relatively short, less than twice length of antennæ; legs yellow; wings yellow, with a rather restricted, chiefly costal, brown pattern; dark area at fork of Sc prolonged backward and outward to include fork of Rs; m-cu some distance before fork of M; male hypopygium with ventral dististyle unusually large, fleshy, rostral prolongation small, pointed at apex, with two straight spines from a low common tubercle; gonapophysis with mesal-apical lobe broad, tip acute.

Male.—Length, excluding rostrum, about 7 millimeters; wing, 7.5; rostrum, about 2.3 to 2.4.

Rostrum relatively short, black throughout, less than twice as long as antennæ. Antennæ with scape and pedicel dark brown, flagellum varying from pale yellowish brown to brown, outer segments darker; flagellar segments oval; terminal seg-

ment longer than penultimate. Head black, striplike anterior vertex silvery gray, this color continued caudad onto posterior vertex.

Mesonotal præscutum plumbeous brown, with three very poorly indicated darker-brown stripes; lateral border of sclerite paling to obscure yellow; scutal lobes plumbeous brown, their mesal edges with a darker-brown line that is a posterior continuation of lateral præscutum stripes; scutellum testaceous brown; postnotum dark. Pleura almost uniformly brownish testaceus. Halteres with stem yellow, knob infuscated. Legs with coxæ testaceous yellow; trochanters yellow; remainder of legs yellow, with only terminal tarsal segments darkened. Wings (Plate 1, fig. 8) with ground color yellow, slightly brighter in prearcular and costal fields; a conspicuous brown costal pattern, as follows: first area at h, continued caudad over arculus; second area at supernumerary crossvein in cell Sc, extending from C almost to M, nearly parallel-sided; third area at origin of Rs, slightly narrower and a little longer than second; fourth area at fork of Sc, continued caudad and slightly distad to involve fork of Rs; fifth area at stigma; sixth at tip of R_3, crossing cell to vein R_{4+5}; dark costal areas conspicuously narrower than interspaces; additional dark seams on cord, m-cu, outer end of cell 1st M_2 and at tip of vein R_{4+5}; barely indicated marginal clouds at ends of veins M_4 to 2d A, inclusive; a very faint darkening in cell Sc between first and second major costal areas; veins yellow, darker in patterned areas. Costal fringe relatively short. Venation: Sc unusually long, Sc_1 ending a short distance before fork of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 in virtual transverse alignment; cell 1st M_2 about as long as vein M_{1+2} beyond it; m-cu approximately its own length before fork of M; vein 2d A strongly sinuous, cell wide.

Abdominal tergites dark brown, caudal borders of segments narrowly pale; sternites more extensively yellow, slightly darkened before tips; subterminal segments, including hypopygium, uniformly infuscated; ventral dististyle very large, conspicuously yellow. Male hypopygium (Plate 3, fig. 36) with lateral lobes of tergite, *9t*, low. Basistyle, *b*, small, its area scarcely one-fifth that of the very large and tumid ventral dististyle, *vd;* setæ of latter virtually lacking on mesal face; rostral prolongation small, pointed at apex, with two rostral spines from a common tubercle or from two very closely approximated tubercles; spines subequal to one another, placed close together,

straight, tips relatively blunt. Gonapophyses, *g*, dark-colored, mesal-apical lobe very broad, its tip acute, margin microscopically and irregularly toothed. Ædeagus, *a*, relatively narrow, the two apical lobes separated by a narrow notch.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*). Paratopotype, male, pinned with type.

Most generally similar to *Limonia* (*Geranomyia*) *suensoniana* Alexander, of eastern China, and to *L.* (*G.*) *radialis* Alexander, ranging from southern Japan to western China, especially in the great length of vein Sc and the basal position of m-cu. It differs in the details of pattern of the thorax and wings and especially in the structure of the male hypopygium, notably the very large ventral dististyle, the pointed apex of the rostral prolongation, and the quite distinct conformation of the lobes of the gonapophyses.

HELIUS (HELIUS) FRANCKIANUS sp. nov. Plate 1, fig. 9; Plate 3, fig. 37.

Large (wing, male, 9 millimeters); general coloration dark gray; halteres uniformly pale yellow; legs yellow; wings brownish yellow, prearcular and costal fields conspicuously light yellow; a sparse darkened pattern, including stigma, wing tip, and clouds in axillary region; Sc long, Sc_1 ending beyond fork of Rs; Rs short, oblique, subequal in length to cell 1st M_2; m-cu close to fork of M; male hypopygium with inner dististyle long and slender, much exceeding short bispinous outer dististyle.

Male.—Length, about 10 millimeters; wing, 9; antenna, about 1.2.

Rostrum a little longer than remainder of head, black throughout; palpi black. Antennæ short, a little longer than rostrum; scape and pedicel black, flagellum brown; flagellar segments oval, passing through elongate oval to attenuate; terminal segment unusually long; verticils subequal in length to segments, on basal portion of flagellum unilaterally arranged. Head dark gray; anterior vertex a little wider than diameter of scape.

Cervical region black. Pronotum and mesonotum almost uniformly blackish gray, præscutal stripes not or scarcely evident. Pleura blackish gray, including dorsopleural membrane. Halteres uniformly pale yellow. Legs with coxæ pale, fore pair a little more darkened; trochanters yellow; femora bright yellow, tips not or scarcely darkened; remainder of legs bright yellow,

terminal tarsal segments darkened; claws simple. Wings (Plate 1, fig. 9) brownish yellow, prearcular and costal fields conspicuously light yellow; stigma oval, dark brown; a scarcely apparent brown seam on anterior cord; wing tip narrowly darkened; a brown seam along basal portion of vein Cu in cell M; axillary region weakly darkened; veins pale brown, clear luteous in clearer yellow areas. Venation: Sc long, Sc_1 ending beyond fork of Rs, Sc_2 at tip; Rs short, oblique, subequal in length to cell 1st M_2; branches of Rs weakly divergent at outer ends so cell R_3 is wider at margin than cell R_2; cell 1st M_2 subrectangular, shorter than veins beyond it; m-cu close to or just beyond fork of M.

Abdomen brownish black, hypopygium a trifle brightened. Male hypopygium (Plate 3, fig. 37) with lateral lobes of tergite, *9t*, appearing as oval flattened plates, apex of each produced into a long straight spine. Basistyle, *b*, without lobes; setæ of narrowed apical portion elongate. Outer dististyle, *od*, short, glabrous, bispinous at apex. Inner dististyle, *id*, unusually long and slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*).

I take unusual pleasure in dedicating this fine species to the Reverend Mr. George Meredith Franck, to whose friendly interest and enthusiasm we owe much of our knowledge of the Tipulidæ of western China. This conspicuous fly is very distinct from all other species so far described from Asia.

ORIMARGA (ORIMARGA) GUTTIPENNIS sp. nov. Plate 1, fig. 10; Plate 3, fig. 38.

Very large (wing, male, over 7 millimeters); general coloration dark gray; antennæ black throughout; halteres pale yellow; legs brownish black; wings pale yellow, sparsely patterned with brown; costal fringe short; numerous macrotrichia on longitudinal veins beyond cord, with exception of R_{2+3}; free tip of Sc_2 distinct; R_{2+3} longer than R_{1+2}; male hypopygium with basistyle simple.

Male.—Length, about 11 millimeters; wing, 7.6.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval to long-oval, verticils short. Head dark gray.

Mesonotum uniformly dark gray, præscutum without stripes. Pleura dark gray, vaguely striped longitudinally with paler on dorsal sternopleurite and ventral pteropleurite. Halteres pale yellow. Legs with the coxæ dark brown, posterior pair a little

paler; trochanters testaceous; remainder of legs brownish black, femoral bases a little paler. Wings (Plate 1, fig. 10) pale yellow, sparsely patterned with brown, including spots at origin and fork of Rs, fork of Sc, free tip of Sc_2, R_2, cord, fork of M_{3+4}, and m-cu; veins yellow, brown in clouded areas. Costal fringe short; macrotrichia on longitudinal veins beyond cord with exception of R_{2+3}. Venation: Sc_1 ending a short distance beyond fork of Rs, Sc_2 close to its tip; Rs angulated at origin; free tip of Sc_2 distinct, R_1 beyond it a little longer than R_2; R_{1+2} long, subequal to vein $Sc_2 + R_1$; R_{2+3} longer than R_{1+2}; basal section of R_{4+5} angulated at origin; m-cu about opposite three-fourths length of Rs; vein 2d A long, cell wide.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 38) with basistyle, *b*, simple; interbases, *i*, appearing as blackened rods, tips narrowed into needlelike whitened points. Outer dististyle, *od*, a simple straight rod, tip gradually narrowed to a slightly decurved point. Inner dististyle a little shorter, entirely pale, with coarse setæ. Phallosome, *p*, appearing as two very slender divergent rods that bear an outer flange of almost hyaline membrane (the latter not shown in figure).

Habitat.—China (Szechwan).

Holotype, male, Mount Owei, Flying Bridges, altitude 3,000 feet, June 2, 1938 (*Tsen*).

Orimarga (Orimarga) guttipennis is very distinct from all described regional species of the genus by the unusually large size and spotted wings. By my key to the Chinese species of *Orimarga* [3] it runs to the almost equally large *O. (O.) latissima* Alexander, which is distinguished by the even wider, unpatterned wings and by the very different male hypopygium.

PEDICIINI

DICRANOTA (RHAPHIDOLABIS) ANGUSTISTYLA sp. nov. Plate 1, fig. 11; Plate 3, fig. 39.

General coloration light gray; antennæ 15-segmented, segments stout and well-delimited; legs black, femoral bases obscure yellow; wings subhyaline, stigma pale brown; Rs relatively short; male hypopygium with tergite deeply bilobed, mesal angle of lobes with long setæ; interbase very large and complex in structure, at apex expanded into a multispinous head; both dististyles slender.

Male.—Length, about 6.5 millimeters; wing, 6.5.

[3] Philip. Journ. Sci. 54 (1934) 327.

Rostrum and palpi black. Antennæ black throughout, 15-segmented; flagellar segments stout and well-delimited, terminal segment reduced; flagellar segments with abundant white pubescence. Head gray.

Mesonotum light gray, præscutum apparently with darker stripes, but badly discolored in unique type. Halteres with stem pale, knob darkened. Legs with coxæ dark; trochanters brownish testaceous; remainder of legs black, femoral bases obscure yellow. Wings (Plate 1, fig. 11) subhyaline, stigma pale brown; veins brown. Venation: Rs relatively short, arcuated; R_{2+3+4} longer than basal section of R_5; m-cu more than one-half its length beyond fork of M.

Abdomen brownish black; hypopygium black. Male hypopygium (Plate 3, fig. 39) with tergite, *9t*, deeply bilobed, lobes separated by a very deep U-shaped notch, opening of notch slightly narrower than base; lobes broad, outer mesal angle rounded and provided with abundant long setæ. Interbase, *i*, very large and complex in structure, at apex expanded into a multispinous head, one spine much longer and larger than the others. Both dististyles very slender, the outer, *od*, dusky, weakly sinuous, clothed with conspicuous setæ. Inner dististyle, *id*, a long narrow yellow blade, at base produced into a narrow lobe.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

Dicranota (*Rhaphidolabis*) *angustistyla* is very different from all other regional species of the subgenus having the tergite of the male hypopygium deeply lobed, as *D.* (*R*) *biloba* Alexander and *D.* (*R.*) *præcisa* Alexander. The species is well distinguished by the narrow elongate dististyles and especially by the complex spinous interbases.

HEXATOMINI

LIMNOPHILA (LIMNOPHILA) FENESTRELLA sp. nov. Plate 1, fig. 12; Plate 3, fig. 40.

General coloration dark brown; antennæ with scape black, basal flagellar segments yellow; legs light yellow; wings pale yellow, variegated with five crossbands that consist of a darkened center surrounded by a narrower brown border that is separated from the center by a narrow line of the ground color; cell M_1 long, m short to very short; male hypopygium with tip of outer dististyle a simple acute point; gonapophyses appearing as flattened spatulate blades.

Male.—Length, about 6.5 millimeters; wing, 7.

Rostrum and palpi black. Antennæ with scape black, pedicel brown; basal flagellar segments subglobular to short-oval, yellow; outer segments somewhat darker, passing into oval, with long conspicuous verticils. Head dark grayish brown; anterior vertex broad.

Mesonotum uniformly dark brown, without stripes or other markings. Pleura black, sparsely pruinose. Halteres pale. Legs with coxæ brownish black; trochanters obscure brownish yellow; remainder of legs light yellow; terminal tarsal segments broken. Wings (Plate 1, fig. 12) pale yellow, with a handsome, very conspicuous, crossbanded and ocellate brown pattern; five crossbands, fourth at cord, fifth apical; three basal bands before cord, first at arculus, third at level of origin of Rs; all bands consisting of a central mark with a narrower brown border, separated from the main dark area by ground areas that are a little wider than the outer dark borders; basal three bands contiguous or confluent in cell M; two outer bands nearly contiguous above fork of M_{1+2}; all bands with pale centers in cell C; a narrow but entire band of ground color before cord, separating third and fourth ocellate areas; veins yellow, darker where traversing brown bands. Venation: Sc_1 ending about opposite fork of Rs, Sc_2 near its tip; R_2 and R_{1+2} subequal; R_{2+3+4} a little shorter than basal section of R_5; cell M_1 shorter than its petiole; m short to very short; in left wing of type M_3 connecting M_{1+2} with M_{3+4} before fork of M_3; m-cu at near one-third length of cell 1st M_2.

Abdomen brownish black, bases of segments a little brighter than tips; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 40) with basistyle, *b*, simple; setæ of mesal face long and erect. Outer dististyle slender, apex slightly decurved to a spinous point; before spine on lower face dilated into a weak flange. Inner dististyle, *id*, a short stout fleshy lobe. Gonapophyses, *g*, appearing as flattened spatulate blades, elongate heads with smooth margins. Ædeagus strongly bent before tip, subtended beneath by pale membrane.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*).

Most closely related to *Limnophila* (*Limnophila*) *aino* Alexander, of northern Japan, and *L.* (*L.*) *dicranophragmoides* Alexander, of the Riukiu Islands, differing especially in the venation and the nature of the wing pattern.

LIMNOPHILA (PRIONOLABIS) LICTOR sp. nov. Plate 1, fig. 13; Plate 3, fig. 41.

Very small (wing, male, under 5 millimeters); mesothorax polished black; basal flagellar segments obscure yellow; head dark gray; legs yellow, tips of femora, tibiæ, and basitarsi darkened; wings yellow, diffusely but extensively patterned with brown; R_{2+3+4} a little longer than basal section of R_5; cell M_1 lacking; male hypopygium with gonapophyses blackened, appearing as stout rods, at apex expanded into subcircular heads, margin with about eleven retrorse teeth.

Male.—Length, about 4.5 millimeters; wing, 4.8.

Rostrum and palpi black. Antennæ with scape and pedicel black; basal flagellar segments obscure yellow, outer segments darker; flagellar segments oval, verticils slightly longer than segments. Head dark gray.

Mesothorax polished black unvariegated, dorsal pleurites a trifle more pruinose. Halteres with stem obscure yellow, knob broken. Legs with coxæ blackened; trochanters obscure yellow; femora yellow, tips rather narrowly (about distal eighth) but conspicuously blackened, the amount subequal on all legs; tibiæ and basitarsi yellow, tips more narrowly blackened; remainder of tarsi brownish black. Wings (Plate 1, fig. 13) with the ground color yellow, clearer yellow in prearcular and costal fields; stigma brown; an extensive but very diffuse paler-brown pattern appears as broad crossbands at level of arculus, origin of Rs and cord; apical cells slightly more infumed than ground; veins brown, yellow in luteous areas. Venation: Sc_1 ending about opposite fork of Rs, Sc_2 near its tip; Rs long, subequal in length to its anterior branch; R_{2+3+4} a little longer than basal section of R_5; cell M_1 lacking; m-cu at near one-third length of cell 1st M_2.

Abdomen including hypopygium, black. Male hypopygium (Plate 3, fig. 41) with caudal border of tergite, *9t*, with a broad U-shaped notch, lobes glabrous and obtuse. Outer dististyle, *od*, with more than basal half dilated and with conspicuous setæ, apex narrowed into a slender spinous blade. Inner dististyle, *id*, with base slightly swollen and setiferous, apex prolonged into a long slender yellow blade that is subequal in length and size to the beak of the outer style but with the apex more obtuse. Gonapophyses, *g*, blackened, appearing as stout rods, at apex expanded into subcircular heads, margin with about eleven retrorse teeth. Ædeagus, *a*, only feebly dilated, apex decurved.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

Limnophila (*Prionolabis*) *lictor* is very different from the other known regional species of the subgenus having cell M_1 of the wings lacking. The strongly darkened gonapophyses, with expanded macelike head, are quite different from that of all other species.

LIMNOPHILA (PRIONOLABIS) POLIOCHROA sp. nov. Plate 1, fig. 14; Plate 4, fig. 42.

General coloration dark gray, thorax without markings; halteres yellow; femora yellow, tips abruptly blackened, the amount subequal on all legs; wings brownish yellow, restrictedly patterned with brown; cell M_1 lacking; m-cu at or before midlength of cell 1st M_2; abdomen black; male hypopygium with gonapophyses appearing as long, slender, simple, gently curved, black rods, tips narrow and subacute, set with microscopic denticles.

Male.—Length, about 6 millimeters; wing, 6.5.

Female.—Length, about 6 to 6.5 millimeters; wing, 6.5 to 7.

Rostrum black, sparsely pruinose; palpi black. Antennæ of moderate length, black, flagellum a little paler, scape pruinose; flagellar segments oval. Head heavily light gray pruinose.

Thorax uniformly dark gray, unpatterned. Halteres yellow, base of stem a little more infuscated. Legs with coxæ dark gray; trochanters black; femora yellow, tips rather narrowly and abruptly blackened, the amount subequal on all legs and including about the distal sixth or seventh; tibiæ obscure yellow, tips blackened; basitarsi brown, remaining tarsal segments passing into black. Wings (Plate 1, fig. 14) brownish yellow, prearcular region clearer yellow; a restricted darker-brown pattern, as follows: origin of Rs, stigma, cord, and axillary region; less evident darkenings at outer end of cell 1st M_2 and along vein Cu; veins pale brown, a little darker in clouded portions, more luteous in yellow areas. Venation: Sc_1 ending about opposite or slightly before fork of Rs, Sc_2 a short distance from its tip; R_{2+3+4} shorter than basal section of R_5; R_2 and R_{1+2} subequal; cell M_1 lacking; m-cu at or before midlength of lower face of cell 1st M_2.

Abdomen black, including hypopygium; valves of ovipositor horn yellow. Male hypopygium (Plate 4, fig. 42) with caudal margin of tergite, *9t,* with a broad U-shaped notch, lobes triangular in outline. Outer dististyle, *od,* moderately chitinized, basal portion weakly expanded, with long setæ; apex flattened

into a blade, terminating in a small decurved point. Inner dististyle, *id*, with base dilated, provided with coarse setæ, the long blackened beak simple, nearly straight, tip subacute. Gonapophyses, *g*, appearing as long, slender, simple, gently curved, black rods, tips narrow and subacute, set with microscopic denticles.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Hwa Nien Pin Temple, altitude 6,500 feet, June 15, 1938 (*Tsen*). Allotopotype, female. Paratopotype, 1 female.

Limnophila (*Prionolabis*) *poliochroa* is very different from the other species of the subgenus in eastern Asia having the body coloration gray and cell M_1 of the wings lacking. The most evident specific characters are to be found in the structure of the male hypopygium, especially the gonapophyses.

LIMNOPHILA (ADELPHOMYIA) SIMPLICISTYLA sp. nov. Plate 1, fig. 15; Plate 4, fig. 43.

General coloration medium brown, præscutum subnitidous, without distinct stripes; basal flagellar segments yellow; halteres pale; legs yellow, terminal tarsal segments infuscated; wings strongly tinged with brownish yellow; sparse macrotrichia in outer ends of cells R_3 to M_4, with exception of R_4; R_{2+3} and R_{1+2} subequal in length, R_2 very faintly indicated; cell M_1 about twice its petiole; m-cu at near midlength of cell 1st M_2; male hypopygium with outer dististyle long and slender, black, apex bifid; inner dististyle simple; gonapophyses appearing as angular hooks.

Male.—Length, about 5 millimeters; wing, 5.5; antenna, about 1.5.

Rostrum ochreous; palpi light brown. Antennæ of moderate length; scape and pedicel brownish yellow, flagellum light yellow, outer segments darker; flagellar segments with conspicuous verticils that exceed segments in length. Head pale brown, pruinose.

Pronotum yellowish brown. Mesonotum almost uniformly medium brown, præscutum subnitidous, without distinct stripes. Pleura brown. Halteres pale. Legs yellow, terminal tarsal segments infuscated. Wings (Plate 1, fig. 15) strongly tinged with brownish yellow; stigma scarcely darker; veins and macrotrichia brown. Sparse macrotrichia in outer ends of cells R_3 to M_4, inclusive, with exception of cell R_4 (indicated in figure by

stippling). Venation: Sc moderately long, Sc_1 ending a short distance before fork of Rs, Sc_2 a short distance from its tip; R_2 very pale to subobsolete; R_{2+3} subequal to R_{1+2}; cells beyond cord relatively deep, especially cells R_3 and M_1; veins comprising anterior cord in transverse alignment; r-m arcuated; cell M_1 nearly twice as long as its petiole; cell 1st M_2 rectangular, with m-cu at near midlength.

Abdomen light brown; hypopygium yellow. Male hypopygium (Plate 4, fig. 43) with caudal margin of tergite transverse or feebly emarginate, without lobes. Outer dististyle, *od*, long and slender, blackened, outer portion strongly curved and narrowed, apex unequally bifid. Inner dististyle, *id*, shorter than outer, simple, lower face with abundant long setæ. Interbases, *i*, appearing as short plates, tips obtusely rounded. Gonapophyses appearing as strongly angulate hooks, the long points decussate across ædeagus.

Habitat.—China (Szechwan).

Holotype male, Mount Omei, Hwa Nien Pin Temple, altitude 6,500 feet, June 15, 1938 (*Tsen*).

I am referring this fly to the subgenus *Adelphomyia* Bergroth (*Tricholimnophila* Alexander) because of the structure of the antennæ and presence of macrotrichia in the outer wing cells. It differs from the other known species of the subgenus in the structure of the male hypopygium, notably the simple inner dististyle.

ELEPHANTOMYIA INSOLITA sp. nov. Plate 1, fig. 16.

General coloration dull black; rostrum unusually long, subequal to either body or wing; fore femora extensively blackened, posterior femora with tips narrowly darkened; all tibiæ and tarsi yellow; wings yellowish brown, unmarked except for a slightly darker brown stigma.

Female.—Length, excluding rostrum, about 9 millimeters; wing, 9; rostrum, about 9.

Rostrum brown, of unusual length, about equal in length to remainder of body or wing. Antennæ with scape and pedicel black, flagellum brown; flagellar segments cylindrical, outer segments more elongate; basal segment of flagellum more than one and one-half times as long as second; first and third subequal; terminal segment nearly as long as penultimate. Head light gray; eyes large; vertex reduced to a narrow stripe that is a little less than diameter of scape.

Thorax uniformly black, with a gray pruinosity to produce a plumbeous appearance; dorsopleural membrane restrictedly obscure yellow. Halteres brownish yellow, base of stem somewhat clearer yellow. Legs with coxæ yellow, fore pair a little darkened; trochanters yellow; femora obscure yellow basally, passing into brownish black, the latter very broadly so on fore and middle legs, on posterior legs tips narrowly darkened; tibiæ slightly infumed basally, soon passing into yellow; tarsi yellow; tibial spurs lacking; claws simple. Wings (Plate 1, fig. 16) strongly tinged with yellowish brown, prearcular field restrictedly yellow; stigma long-oval, pale brown, only a little darker than ground; veins pale brown. Venation: Sc_1 ending opposite fork of Rs, Sc_2 a little longer, near its tip; Rs relatively short, less than cell 1st M_2, angulated and short-spurred at origin; branches of Rs generally parallel to one another; m-cu shortly beyond midlength of cell 1st M_2; cell 2d A relatively narrow.

Abdomen, including genital shield, black; valves of ovipositor horn-yellow, hypovalvæ blackened at bases.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

The nearest ally of the present fly is *Elephantomyia carbo* Alexander, likewise from the mountains of western China, differing especially in the polished black thorax, darkened tibiæ, and conspicuously patterned wings.

ERIOPTERINI

LIPSOTHRIX MIRABILIS sp. nov. Plate 1, fig. 17; Plate 4, fig. 44.

General coloration polished black; antennæ (male) elongate; legs black, terminal tarsal segments somewhat paler; wings yellowish brown, conspicuously patterned with darker brown, including costal border and broad seams along cord, outer end of cell 1st M_2, and vein Cu; R_{2+3+4} suberect, unusually short, less than basal section of R_5; Rs long, subequal to vein R_4; male hypopygium with interbases unusually long and slender, at near midlength bent into a right angle, tip acute.

Male.—Length, about 9 millimeters; wing, 9.5; antenna, about 3.5.

Rostrum and palpi black. Antennæ black throughout, elongate (male) as shown by measurements; flagellar segments subcylindrical, verticils shorter than segments; terminal segment about one-third penultimate. Head black, heavily pruinose, especially on broad anterior vertex.

Thorax polished black, notum glabrous. Halteres with stem pale, knob weakly darkened. Legs with coxæ polished black; trochanters abruptly yellow; remainder of legs black, femoral bases very narrowly yellow, outer tarsal segments paling to brown; claws conspicuously toothed, including a larger spine before midlength and a smaller, more basal one. Wings (Plate 1, fig. 17) yellowish brown, conspicuously patterned with darker brown, including cells C and Sc, and seams on R_2, R_{1+2}, cord, and outer end of cell 1st M_2, with a longitudinal seam along vein Cu; outer radial field more vaguely darkened; veins beyond cord, as well as posterior wing margin, indistinctly clouded; posterior prearcular field clear yellow; veins brown, more yellowish in the more basal unclouded portions. Macrotrichia of veins relatively long and conspicuous on veins beyond cord, less numerous elsewhere, including a few on outer ends of Rs and 2d A. Venation: Sc long, Sc_1 ending beyond fork of R_{2+3+4}, Sc_2 at its tip; Rs long, subequal to R_4; R_{2+3+4} unusually short and suberect, less than basal section of R_5; cell M_1 lacking; cell 1st M_2 relatively large, subrectangular, with oblique m-cu at near one-fourth its length.

Abdomen, including hypopygium, black. Male hypopygium (Plate 4, fig. 44) of normal structure; inner dististyle, *id*, longer than outer, *od*, pointed at tip. Interbase, *i*, long and slender, bent at right angle at near midlength, tip acute.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, June 7, 1938 (*Tsen*).

Lipsothrix mirabilis is entirely different from all species of the genus hitherto made known. It is most similar to *L. pluto* Alexander, of the higher mountains of Formosa, which has a similarly blackened thorax and elongate antennæ in the male sex. The present fly differs conspicuously in the patterned wings and in the venation, as the unusually short R_{2+3+4}. In its general appearance the fly suggests species of *Limnophila* belonging to the subgenus *Prionolabis* Osten Sacken. It is the first species of *Lipsothrix* to be reported from China.

GONOMYIA (IDIOCERA) MULTIARMATA sp. nov. Plate 1, fig. 18; Plate 4, fig. 45.

General coloration gray, præscutum with two intermediate brown stripes; legs obscure yellow; wings brownish yellow, restrictedly patterned with darker brown, including stigma, wing tip and restricted seams at origin of Rs, cord and m-cu; Sc short, Sc_1 ending about opposite one-fifth length of Rs; male

hypopygium with all three dististyles bearing conspicuous branches; ædeagus elongate, simple.

Male.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ with basal segments yellow; flagellar segments beyond first black; basal flagellar segments subcylindrical, outer segments more fusiform, with truncated ends. Head gray.

Pronotum light gray. Mesonotal præscutum gray, humeral and lateral portions pale yellow; two intermediate brown stripes that are more expanded behind, interspace more obscured; pseudosutural foveæ pale; scutum with lobes grayish brown; scutellum dark brown, sparsely pruinose, caudal margin obscure yellow; mediotergite dark gray. Pleura dark gray, with a conspicuous, pale, longitudinal stripe involving dorsal sternopleurite, continued caudad and becoming more expanded behind, reaching base of abdomen; dorsopleural membrane pale. Halteres with stem yellow, knob weakly darkened. Legs with coxæ and trochanters yellow; remainder of legs brownish yellow to obscure yellow, outer tarsal segments darker. Wings (Plate 1, fig. 18) tinged with brownish yellow, restrictedly patterned with darker brown, including stigma; conspicuous wing tip in outer ends of cells R_3 and R_4; small seams at origin of Rs, cord, and m-cu; veins yellow, dark brown in clouded areas. Venation: Sc relatively short, Sc_1 ending about opposite one-fifth length of Rs, Sc_2 opposite origin of latter; R_3 moderately oblique, distance on margin between R_{1+2} and R_3 about one-third length of latter; m-cu a little more than its own length before fork of M.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 4, fig. 45) with apical lobe of basistyle, *b*, elongate. Outer dististyle, *od*, a slender rod terminating in an acute point, on outer margin at near one-third length bearing a long strong spine; shortly before apex with a much smaller appressed spine. Intermediate dististyle, *md*, elongate, bifid, longest arm a flattened, twisted ribbon, longer than other elements of styli; at near midlength the style bears a small curved lateral arm. Inner dististyle, *id*, deeply bifid, outer arm a longer, gently curved spine; inner arm a straight spinous rod, tip acute, near apex with a few setæ. Ædeagus, *a*, elongate, simple, slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*).

Gonomyia (*Idiocera*) *multiarmata* is entirely different from other, now numerous, species of the subgenus in eastern Asia. It is well distinguished by the patterned wings and the unusual armature of the male hypopygium, especially the strongly bifid inner dististyle.

ERIOPTERA (TELENEURA) PERLUGUBRIS sp. nov. Plate 1, fig. 19.

General coloration black, including palpi, antennæ, and halteres; wings strongly blackened; Rs relatively long, about twice length of R_{2+3+4}; abdomen black; ovipositor with strongly upcurved cerci horn-yellow.

Female.—Length, about 5 millimeters; wing, 5.8.

Rostrum and palpi black. Antennæ black, outer flagellar segments paling to dark brown; flagellar segments passing through oval to elongate. Head black.

Thorax uniformly black. Halteres black, base of stem restrictedly obscure yellow. Legs with coxæ blackened; trochanters testaceous yellow; remainder of legs obscure yellowish brown, with a vestiture of still darker setæ and linear scales; tarsi dark. Wings (Plate 1, fig. 19) relatively long and narrow, strongly blackened; veins and trichia still darker. Venation: Rs relatively long, about twice R_{2+3+4}, cells beyond cord long and narrow, as in subgenus.

Abdomen black; ovipositor with strongly upcurved cerci horn-yellow.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

Erioptera (*Teleneura*) *perlugubris* is entirely distinct from the other described Chinese species, differing especially in the black coloration of the body and the darkened tarsi. It is most similar to the subgenotype, *E.* (*T.*) *fusca* de Meijere, of the Austramalayan islands, which differs in the much smaller size and the different venation, Rs being subequal in length to R_{2+3+4}.

ERIOPTERA (EMPEDA) BRACHYCLADA sp. nov. Plate 1, fig. 20; Plate 4, fig. 46.

General coloration light gray; antennæ black; halteres uniformly pale yellow; femora and tibiæ brownish yellow, tips a little darkened; no scales on legs; wings very pale yellow, especially basal and costal portions; veins yellow, brown in darker outer portions; stigma pale brownish yellow; Rs relatively short, subequal to R_4; abdomen, including hypopygium, black; male

hypopygium with stem of outer dististyle unusually short, outer arm shorter than inner, appearing as a curved spine, tip acute; inner arm expanded at apex; inner dististyle pale, at apex dilated into a high glabrous crest.

Male.—Length, about 4.2 to 4.5 millimeters; wing, 4.6 to 5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval. Head dark gray.

Thorax light gray, præscutum without stripes. Pleura gray, dorsopleural region only restrictedly brightened. Halteres uniformly pale yellow. Legs with coxæ reddish brown; trochanters obscure yellow; femora and tibiæ brownish yellow, tips a little darkened; tarsi dark brown to brownish black; legs without scales. Wings (Plate 1, fig. 20) very pale yellow, prearcular and costal fields paler and clearer yellow; cells beyond cord and anal field a little more darkened, best evidenced by darker veins, those in basal portions clear light yellow, including most of Rs; stigma pale brownish yellow. Venation: Sc of moderate length, Sc_1 ending opposite or just beyond midlength of Rs, Sc_2 somewhat variable in position, in cases at near middistance between origin of Rs and tip of Sc_1, in other specimens lying more distad; Rs relatively short, subequal to vein R_4; R_3 oblique, m-cu close to fork of M.

Abdomen, including hypopygium, black. Male hypopygium (Plate 4, fig. 46) with stem of outer dististyle, *od,* unusually short; outer arm shorter than inner, appearing as a curved spine, tip acute, inner or concave edge with a low flange; inner arm expanded at apex. Inner dististyle, *id,* pale, at apex dilated into a high glabrous crest.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, summit, altitude 10,800 to 11,000 feet, June 16, 1938 (*Tsen*). Paratopotype, several males, May 26 to June 16, 1938 (*Tsen*).

Erioptera (*Empeda*) *brachyclada* is most similar to *E.* (*E.*) *sulfureoclavata* Alexander, differing especially in the blackened hypopygium with the details of structure distinct. *E.* (*E.*) *nigrostylata* Alexander has numerous flattened scales on the legs, and the structure of the male hypopygium quite distinct.

ERIOPTERA (EMPEDA) FUSCOCINCTA sp. nov. Plate 1, fig. 21; Plate 4, fig. 47.

Large (wing, male, over 5 millimeters); general coloration clear gray; legs brownish black, without scales; wings tinged with yellow, with a broad brown seam along cord; Sc relatively long, Sc_1 ending beyond four-fifths length of long Rs; R_3 lon-

gitudinal in position; male hypopygium with outer dististyle darkened, deeply bifid, both arms obtuse at tips; gonapophyses appearing as broad pale plates.

Male.—Length, about 5 millimeters; wing, 5.4.

Rostrum and palpi black. Antennæ with scape black, succeeding segments dark brown; basal flagellar segments long-oval, outer segments more elongate and attenuate. Head gray.

Mesonotal præscutum gray, præscutum with poorly indicated pale-brown stripes; scutal lobes weakly darkened. Pleura clear gray. Halteres light orange yellow. Legs brownish black, coxæ pruinose; legs without scales. Wings (Plate 1, fig. 21) tinged with yellow, basal portions even brighter; stigma and a broad confluent seam on cord brown; extreme wing tip infumed; veins pale brown, more yellowish in basal portions. Venation: Sc relatively long, Sc_1 ending beyond four-fifths length of long Rs, Sc_2 a short distance from its tip; R_{2+3+4} a trifle longer than R_2; R_3 longitudinal in position; m-cu at or immediately before fork of M.

Abdomen, including hypopygium, black, pruinose. Male hypopygium (Plate 4, fig. 47) with basistyle terminating in two lobes, stouter lobe with long setæ that equal or exceed the dististyle in length; second lobe smaller, with abundant dense setulæ and a very few long terminal setæ. Outer dististyle, *od*, darkened, deeply bifid, stem subequal in length to longest arm; one arm a little longer than the other, tips of both broadly obtuse. Inner dististyle, *id*, a simple blade, gradually narrowed to subacute tip, surface with several microscopic punctures. Gonapophyses, *g*, appearing as unusually broad and flattened pale plates.

Habitat—China (Szechwan).

Holotype, male, Mount Omei, Flying Bridges Temple, altitude 3,000 feet, June 1, 1938 (*Tsen*).

Erioptera (*Empeda*) *fuscocincta* is readily told from all other regional species of the subgenus by the conspicuously banded wings.

ORMOSIA (ORMOSIA) SUBDUCALIS sp. nov. Plate 1, fig. 22.

Allied to *ducalis;* large (wing, female, over 6.5 millimeters); general coloration black, including antennæ and legs; halteres orange yellow; wings brownish yellow, base clearer yellow; a restricted brown pattern, including stigma, a broad seam entire length of vein Cu, cord and base of vein M_3; cell M_2 open by

atrophy of m; ovipositor with cerci short, strongly upcurved, black at base, tips horn-yellow.

Female.—Length, about 6 to 6.5 millimeters; wing, 7 to 7.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval. Head gray; anterior vertex broad.

Thorax black throughout. Halteres orange yellow. Legs black, extreme bases of femora more brightened. Wings (Plate 1, fig. 22) brownish yellow, base clearer yellow; stigma more infuscated; a broad dusky seam entire length of veins Cu and Cu_1; more restricted dark clouds on cord and along vein M_3; veins pale brown, more yellowish in brightened basal portions. Macrotrichia of wing cells abundant, in all cells beyond arculus with exception of base of Sc (shown in figure by stippling). Venation: Sc_2 far from tip of Sc_1, about opposite one-fifth length of long straight Rs; R_2 subequal to R_{2+3}; cell M_2 open by atrophy of m; cell M_3 moderately deep, its petiole and m-cu subequal; m-cu at fork of M; vein 2d A nearly straight.

Abdomen black, including genital shield and bases of short, strongly upcurved cerci, tips of the latter horn-yellow.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, White Cloud Temple, altitude 9,000 feet, May 25, 1938 (*Tsen*). Paratype, female, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, August 5, 1935 (*Graham*); U. S. Nat. Mus.

The nearest described ally is *Ormosia* (*Ormosia*) *ducalis* Alexander, of northern Korea, which has the same general size, coloration, and venation, differing especially in the uniformly darkened wings, with slight differences in venation, especially in the shorter veins, R_{2+3+4} and M_{3+4}.

ORMOSIA (ORMOSIA) INÆQUISPINA sp. nov. Plate 1, fig. 23; Plate 4, fig. 48.

Belongs to the *similis* group; general coloration dark brown; antennæ (male) elongate, exceeding one-half length of body; flagellar segments fusiform, with conspicuous, erect, dark-colored setæ; wings with a brownish tinge, stigma darker; vein 2d A sinuous; male hypopygium with gonapophyses appearing as long, slender, curved spines, on outer margin beyond base bearing a long, slender, nearly straight spine.

Male.—Length, about 4 millimeters; wing, 4.7; antenna, about 2.5.

Rostrum dark brown; palpi black. Antennæ black throughout, elongate, if bent backward extending to beyond base of abdomen; flagellar segments fusiform, with conspicuous, erect,

dark-colored setæ that are subequal to length of segments. Head dark brown.

Thorax dark brown, pleura sparsely pruinose. Halteres dusky, with golden-yellow setæ. Legs with coxæ dark brown; trochanters testaceous; remainder of legs dark brown. Wings (Plate 1, fig. 23) with a brown tinge, stigma darker brown; veins pale brown. Macrotrichia of cells abundant (indicated in figure by stippling). Venation: Sc_1 ending opposite or just beyond R_2; Rs relatively short, subequal to R_3; R_2 at fork of R_{2+3+4}; cell M_2 open by atrophy of basal section of M_3; m-cu at fork of M; vein 2d A sinuous.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 4, fig. 48) with both dististyles dusky; outer style, *od*, unusually small, oval in outline; inner style, *id*, prolonged into a slender apical point. Gonapophysis, *g*, appearing as long, slender, curved spines, blackened tips acute; on outer margin beyond base a long, slender, nearly straight, acute spine, entirely pale and about one-half as long as major axial apophysis.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

Ormosia (*Ormosia*) *inæquispina* is closest to *O.* (*O.*) *tenuispinosa* Alexander, which has somewhat similar antennæ in the male but the flagellar setæ pale and inconspicuous though long. The male hypopygium, especially the gonapophyses, is quite different in the two flies.

ORMOSIA (ORMOSIA) DECORATA sp. nov. Plate 1, fig. 24; Plate 4, fig. 49.

Belongs to the *similis* group; general coloration of thorax uniformly dark gray; antennæ (male) moderately long, if bent backwards extending to beyond wing root; femora brownish yellow basally, at near midlength passing into dark brown; wings yellow, heavily patterned with darker, including major areas at origin of Rs and on cord; cell M_2 open by atrophy of basal section of M_3; vein 2d A weakly sinuous on distal third; male hypopygium with outer gonapophysis a strongly bent rod, long apical portion gradually narrowed into a needlelike spine; inner gonapophysis shorter, very strongly curved, tip blackened and acute.

Male.—Length, about 4 millimeters; wing, 4.5; antenna, about 1.1.

Rostrum black, sparsely pruinose; palpi black. Antennæ moderately long, if bent backward extending to beyond wing

root, black throughout; flagellar segments long-oval, longest verticils much exceeding segments and unilaterally distributed; in addition to verticils, segments with a conspicuous white pubescence. Head dark gray.

Mesonotum uniformly dark gray, with yellow setæ; tuberculate pits black. Pleura black, gray pruinose. Halteres pale yellow. Legs with coxæ plumbeous; trochanters yellow; femora brownish yellow basally, at near midlength passing into dark brown; tibiæ and tarsi dark brown. Wings (Plate 1, fig. 24) with ground color yellow, heavily patterned with darker, including a major area at fork of Sc and origin of Rs, extending caudad virtually to vein M; stigma and a broad confluent seam on cord; smaller dark marginal clouds at ends of longitudinal veins, largest at 2d A; base of cell Cu and fork of M less distinctly clouded; veins yellow, infuscated in clouded portions. Numerous conspicuous macrotrichia in cells of wing (indicated in figure by stippling). Venation: Sc_1 ending a short distance beyond R_2, Sc_2 about opposite one-third to one-fourth length of Rs; R_2 subequal to R_{2+3}; cell M_2 open by atrophy of basal section of M_3; vein 2d A weakly sinuous on distal third.

Abdomen, including hypopygium, brownish black. Male hypopygium (Plate 4, fig. 49) with outer dististyle, *od,* relatively small and slender, the surface with rows of appressed spines, as in group. Inner dististyle, *id,* with apical beak moderately elongate. Outer gonapophysis, *og,* appearing as strongly bent rods, long apical portion very gradually narrowed into a needlelike spine. Inner gonapophysis, *ig,* shorter, very strongly curved, tip blackened and acute.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, White Cloud Temple, altitude 9,000 feet, June 6, 1938 (*Tsen*). Paratopotype, male, Hwa Nien Pin Temple, altitude 6,500 feet, June 15, 1938 (*Tsen*).

Ormosia (*Ormosia*) *decorata* is readily told by the conspicuously patterned wings, darkened legs, and, especially, the structure of the male hypopygium, notably of the gonapophyses. It superficially resembles *O.* (*O.*) *auricosta* Alexander and *O.* (*O.*) *beatifica* Alexander, but is entirely distinct.

MOLOPHILUS (MOLOPHILUS) TSENI sp. nov. Plate 4, fig. 50.

Belongs to the *gracilis* group and subgroup; general coloration of thorax black, præscutum dark reddish brown; halteres pale yellow; legs brownish black; wings with a yellowish-brown

tinge; male hypopygium with the dorsal lobe of basistyle divided into two points, one a nearly straight blackened spine, the other a broader flattened blade; ventral lobe of basistyle unusually small and slender; outer dististyle a glabrous curved hook from a dilated base; inner dististyle smaller, a simple sigmoid rod; phallosomic plate obtuse at apex, surface glabrous.

Male.—Length, about 4 millimeters; wing, about 4.6.

Rostrum and palpi black. Antennæ black throughout. Head dark gray.

Mesonotal præscutum dark reddish brown, contrasting with the black scutum, scutellum, postnotum, and pleura. Halteres pale yellow. Legs with coxæ and trochanters black; remainder of legs brownish black. Wings with a yellowish brown tinge; veins darker brown; trichia, including costal fringe, brownish black. Venation: R_2 lying shortly distad of level of r-m; petiole of cell M_3 more than three times m-cu; vein 2d A long, sinuous, ending about opposite midlength of petiole of cell M_3.

Abdomen black, hypopygium, especially dististyles, a little brightened. Male hypopygium (Plate 4, fig. 50) with dorsal lobe of basistyle, *db*, terminating in two conspicuous points, one a nearly straight blackened spine, the other a little shorter and broader, appearing as a dusky flattened blade, apex obtuse; mesal lobe low and broad; ventral lobe, *vb*, unusually small and slender, with coarse retrorse setæ. Outer dististyle, *od*, a strongly curved, simple hook from a dilated base, distal half narrowed into a long spine, surface of style glabrous. Inner dististyle, *id*, a little shorter, appearing as a simple sigmoid rod, apical third a long straight spine, at point of flexure and on base of apical point with about fifteen setigerous punctures. Phallosomic plate, *p*, obtuse at apex, surface glabrous.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, Chu Lao Tong Temple, altitude 6,500 feet, June 6, 1938 (*Tsen*).

Molophilus (*Molophilus*) *tseni* is named in honor of the collector of this important series of Tipulidæ from Mount Omei, Mr. Tsen Bao-chi. It is readily told from allied generally similar black species by the brightened præscutum and by the structure of the male hypopygium, notably the bifid dorsal lobe of the basistyle, the unusually small and slender ventral lobe, and the conformation of the dististyles.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *db*, dorsal lobe of basistyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *ig*, inner gonapophysis; *md*, intermediate dististyle; *od*, outer dististyle; *og*, outer gonapophysis; *p*, phallosome; *s*, sternite; *t*, tergite; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tipula* (*Nippotipula*) *brevifusa* sp. nov.; venation.
2. *Tipula* (*Vestiplex*) *erectiloba* sp. nov.; venation.
3. *Tipula* (*Vestiplex*) *factiosa* sp. nov.; venation.
4. *Tipula* (*Oreomyza*) *sternosetosa* sp. nov.; venation.
5. *Tipula* (*Oreomyza*) *incisurata* sp. nov.; venation.
6. *Liogma simplicicornis* sp. nov.; venation.
7. *Limonia* (*Dicranomyia*) *amplificata* sp. nov.; venation.
8. *Limonia* (*Geranomyia*) *obesistyla* sp. nov.; venation.
9. *Helius* (*Helius*) *franckianus* sp. nov.; venation.
10. *Orimarga* (*Orimarga*) *guttipennis* sp. nov.; venation.
11. *Dicranota* (*Rhaphidolabis*) *angustistyla* sp. nov.; venation.
12. *Limnophila* (*Limnophila*) *fenestrella* sp. nov.; venation.
13. *Limnophila* (*Prionolabis*) *lictor* sp. nov.; venation.
14. *Limnophila* (*Prionolabis*) *poliochroa* sp. nov.; venation.
15. *Limnophila* (*Adelphomyia*) *simplicistyla* sp. nov.; venation.
16. *Elephantomyia insolita* sp. nov.; venation.
17. *Lipsothrix mirabilis* sp. nov.; venation.
18. *Gonomyia* (*Idiocera*) *multiarmata* sp. nov.; venation.
19. *Erioptera* (*Teleneura*) *perlugubris* sp. nov.; venation.
20. *Erioptera* (*Empeda*) *brachyclada* sp. nov.; venation.
21. *Erioptera* (*Empeda*) *fuscocincta* sp. nov.; venation.
22. *Ormosia* (*Ormosia*) *subducalis* sp. nov.; venation.
23. *Ormosia* (*Ormosia*) *inæquispina* sp. nov.; venation.
24. *Ormosia* (*Ormosia*) *decorata* sp. nov.; venation.

PLATE 2

FIG. 25. *Tipula* (*Vestiplex*) *erectiloba* sp. nov.; male hypopygium, lateral.
26. *Tipula* (*Vestiplex*) *erectiloba* sp. nov.; male hypopygium, ninth tergite.
27. *Tipula* (*Vestiplex*) *factiosa* sp. nov.; male hypopygium, ninth tergite.
28. *Tipula* (*Vestiplex*) *factiosa* sp. nov.; male hypopygium, styli.
29. *Tipula* (*Oreomyza*) *sternosetosa* sp. nov.; male hypopygium, lateral.
30. *Tipula* (*Oreomyza*) *sternosetosa* sp. nov.; male hypopygium, details.
31. *Tipula* (*Oreomyza*) *incisurata* sp. nov.; male hypopygium, lateral.
32. *Tipula* (*Oreomyza*) *incisurata* sp. nov.; male hypopygium, ninth tergite.

PLATE 3

FIG. 33. *Liogma smplicicornis* sp. nov.; antenna, male.
34. *Liogma simplicicornis* sp. nov.; male hypopygium.
35. *Limonia (Dicranomyia) amplificata* sp. nov.; male hypopygium.
36. *Limonia (Geranomyia) obesistyla* sp. nov.; male hypopygium.
37. *Helius (Helius) franckianus* sp. nov.; male hypopygium.
38. *Orimarga (Orimarga) guttipennis* sp. nov.; male hypopygium.
39. *Dicranota (Rhaphidolabis) angustistyla* sp. nov.; male hypopygium.
40. *Limnophila (Limnophila) fenestrella* sp. nov.; male hypopygium.
41. *Limnophila (Prionolabis) lictor* sp. nov.; male hypopygium.

PLATE 4

FIG. 42. *Limnophila (Prionolabis) poliochroa* sp. nov.; male hypopygium.
43. *Limnophila (Adelphomyia) simplicistyla* sp. nov.; male hypopygium.
44. *Lipsothrix mirabilis* sp. nov.; male hypopygium.
45. *Gonomyia (Idiocera) multiarmata* sp. nov.; male hypopygium.
46. *Erioptera (Empeda) brachyclada* sp. nov.; male hypopygium.
47. *Erioptera (Empeda) fuscocincta* sp. nov.; male hypopygium.
48. *Ormosia (Ormosia) inæquispina* sp. nov.; male hypopygium.
49. *Ormosia (Ormosia) decorata* sp. nov.; male hypopygium.
50. *Molophilus (Molophilus) tseni* sp. nov.; male hypopygium.

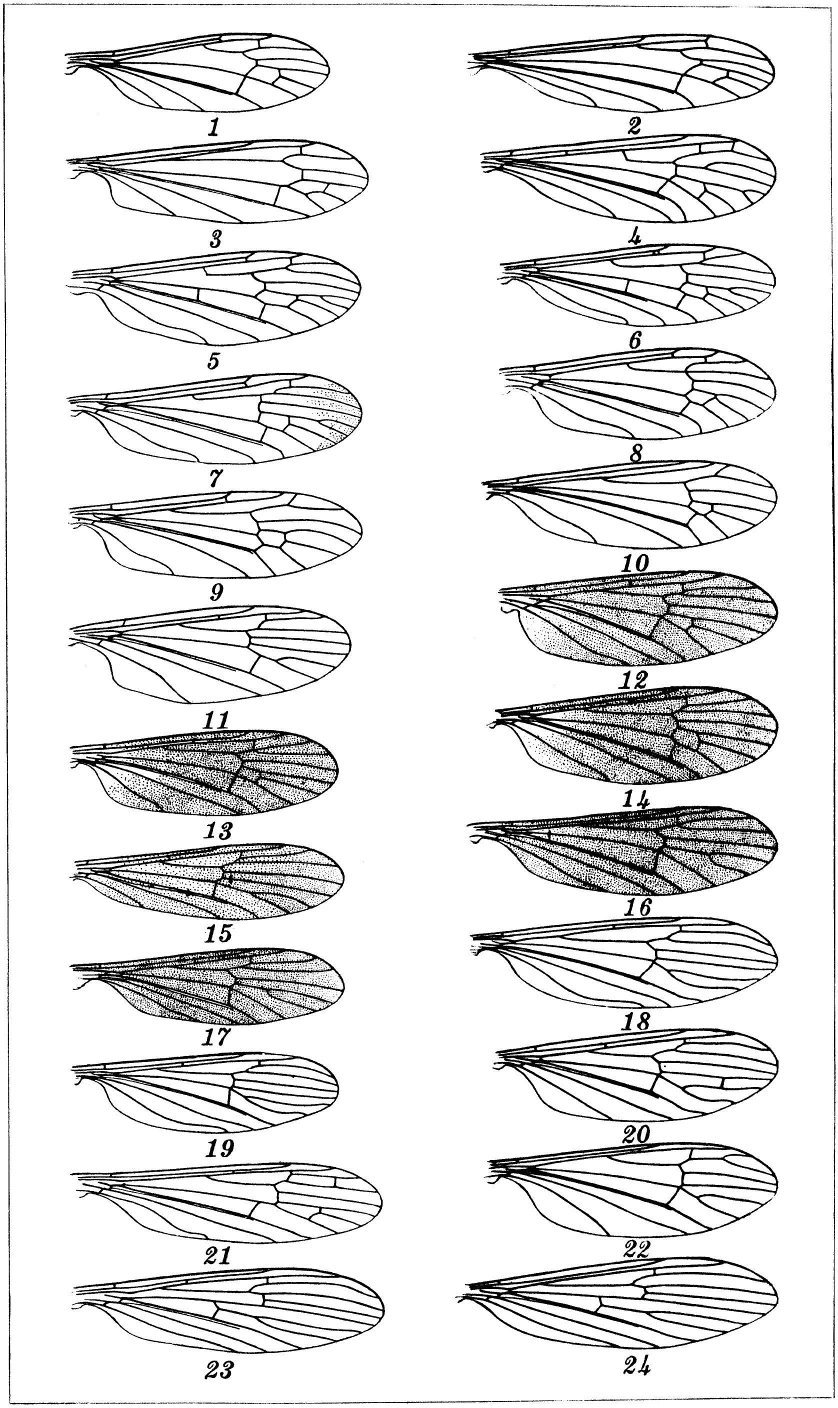

PLATE 1.

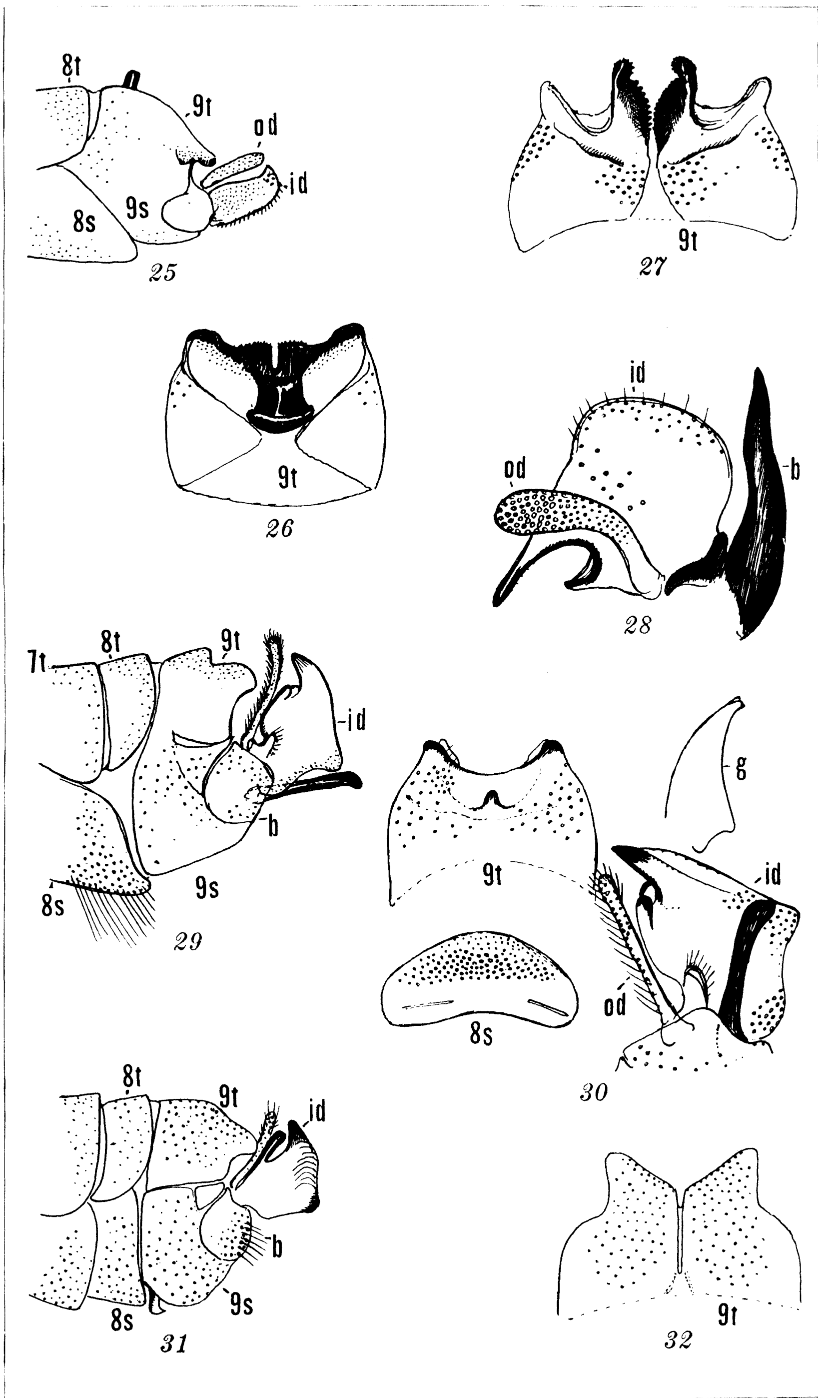
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PLATE 2.

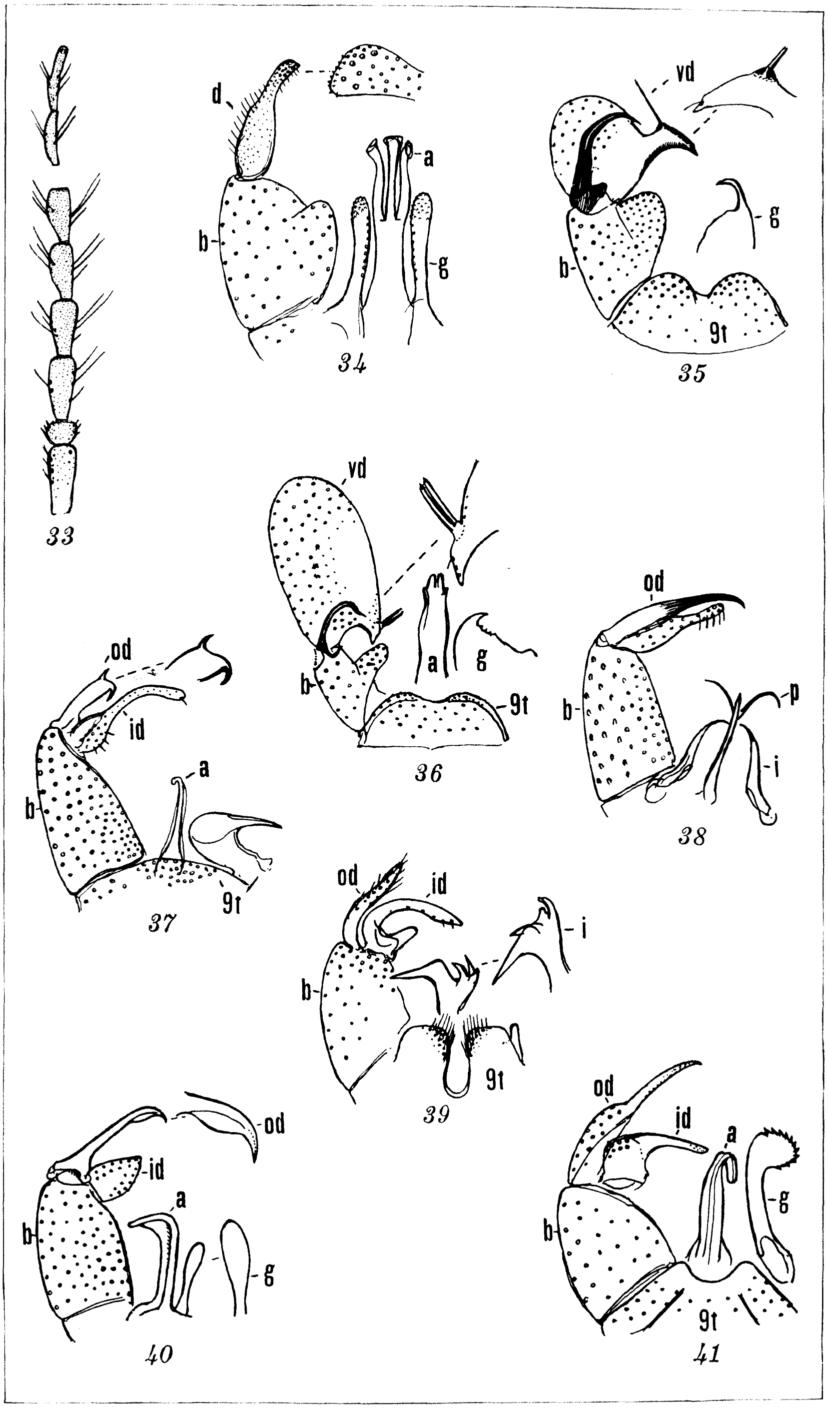
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PLATE 3.

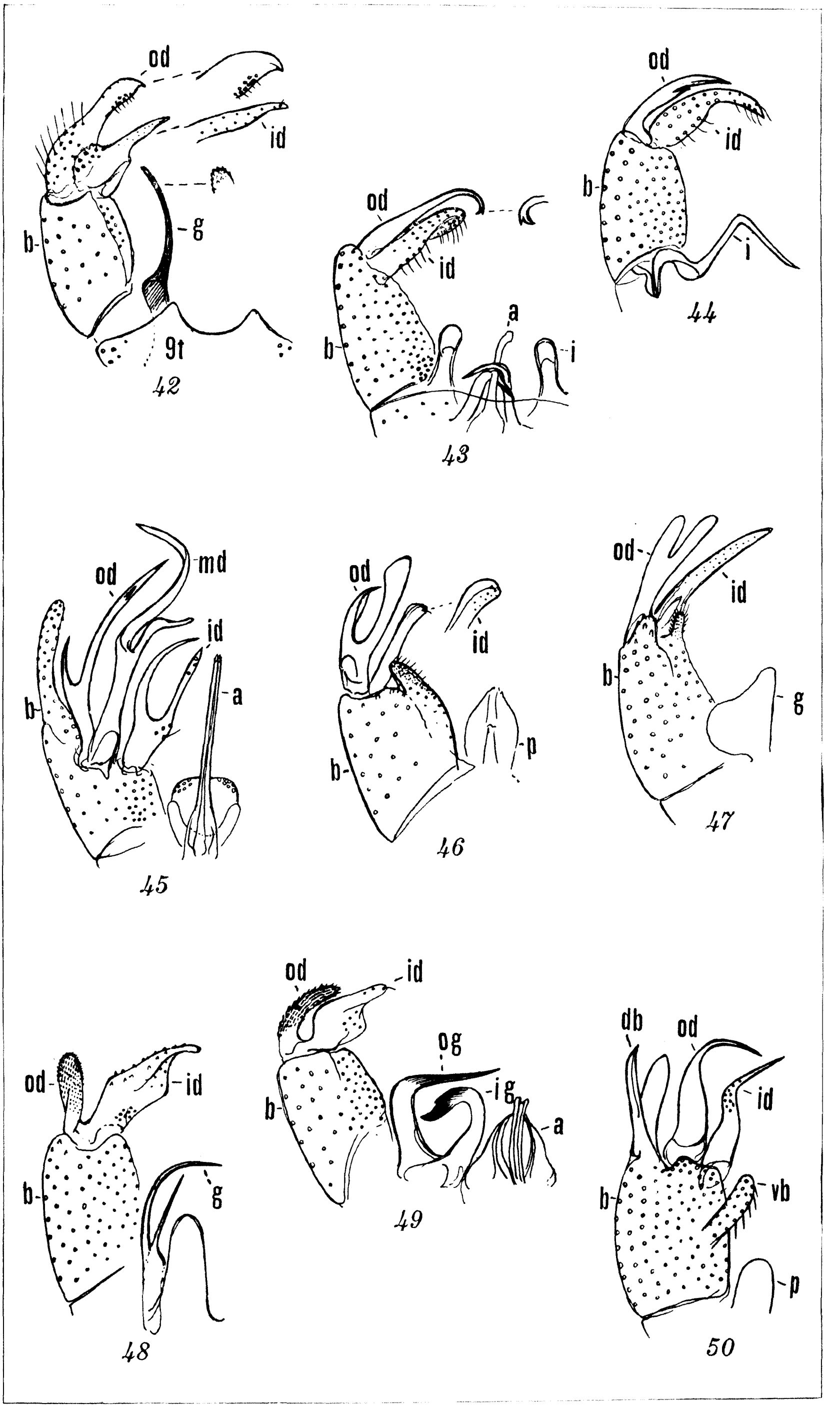
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PLATE 4.

CERATOPOGONIDÆ AND CHIRONOMIDÆ FROM THE MICRONESIAN ISLANDS [1]

WITH BIOLOGICAL NOTES BY TEISO ESAKI [2]

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THREE PLATES

This report is based on a considerable collection made by Prof. Teiso Esaki in the Marianna, Caroline, and Marshall Islands during 1937 and 1938.

The collection consists of 12 species of Ceratopogonidæ (Heleidæ) and 9 species of Chironomidæ (Tendipedidæ). In 1936 I reported *Culicoides pelilioensis* as a biting midge from Palau Island, and at this time I intend to describe another blood-sucking midge, *C. esakii*, which also severely attacks men at Ponape Island, as the second species of troublesome biting midges from the Micronesia Islands. Two other species of the same genus are described and named here, *C. kusaiensis* and *C. ardentissimus*, respectively, but the blood-sucking habits of these species are not ascertained as yet. Three species of ecto-parasitic midges, *Pterobosca adhesipes*, *P. esakii*, and *Lasiohelea pectinunguis*, are also dealt with in this paper. The species of *Pterobosca* were found clinging to the wings of dragon flies and sucking blood, piercing the veins of the wings. The third species was found sucking blood from a sphingid moth. Two other interesting midges are *Tanytarsus halophilæ* and *T. esakii*, the former reported as a marine species in 1926 from the Samoa Islands by Dr. F. W. Edwards. The latter species, newly named, is very closely allied to other known marine species, such as *T. halophilæ*, *T. maritimus*, *T. pontophilus*, and *T. magnihamatus*, in the reduction of the plumose hairs of the male antennæ, in the very small value of the antennal ratio of the

[1] Contribution from the Entomological Laboratory, Kyoto Imperial University, No. 81.

[2] Reports of Prof. T. Esaki's Micronesia Expeditions 1936–1938, No. 21.

male, and in the prolongation of the female cerci. These close morphological relations seem to suggest that the midge is marine in habitat.

The specimens of these Micronesian species are all alcoholic and deposited in the Entomological Laboratory, Kyusyu Imperial University. The morphological terminology used in the text is based on that of a number of my recent papers.

I am most grateful to Prof. Teiso Esaki, director of the Entomological Laboratory, Kyusyu Imperial University, for the opportunity of examining this interesting collection, and I take pleasure in thanking him not only for this privilege but also for many invaluable biological notes kindly furnished by himself in the text. I am also greatly indebted to Prof. Chukichi Harukawa, director of the Entomological Laboratory, Kyoto Imperial University, for his cordial help in the preparation of this report.

CERATOPOGONIDÆ

FORCIPOMYIA ESAKIANA sp. nov.

A beautiful species of moderate size, with yellow and dark markings.

Female.—Body 2.5 to 2.7 millimeters long; legs with many scales; wings darkly fumose, each with a black spot enveloping second radial cell and a large elongated white spot along costal margin beyond radial cells. Head and mouth parts dark brown. Antennæ brown, each with a double-headed stylet; basal segments longer than wide; antennal ratio about 1.4; proportional lengths of distal eight segments 19 : 19 : 19 : 40 : 42 : 40 : 40 : 49. Thorax almost entirely dark brown, dull, hairs yellow; mesoscutum somewhat paler along pseudosutural foveæ and on caudoscutal area. Legs yellow, with scales, each with a dark-brown ring before and beyond knee joint; trochanters dark brown; femora pale yellow; tarsal segments entirely yellowish brown; middle and hind coxæ each with a dark-brown median ring; claws simple; tarsal ratio of hind leg about 0.47. Proportional lengths of segments of legs 34 : 35 : 11 : 15 : 8 : 6 : 5 in foreleg, 41 : 47 : 9 : 20 : 9 : 6 : 5 in middle leg, and 45 : 45 : 10 : 21.5 : 10 : 8 : 5.5 in hind leg. Wings (Plate 1, fig. 2) dark, each with a black spot covering second radial cell, a white large spot beyond end of costa, a faint paler spot covering r-m; intercalary fork in cell R_5 obscure. Venation: costa ending at middle of wing, first radial cell slitlike, second radial cell short and barely longer than first, bases of M_1 and M_2 atrophied,

fMCu under second radial cell. Halteres white. Abdomen with terga dark brown, pleural sides yellowish white and clothed with dark hairs, sternal side yellowish white and with a pair of lateral brown stripes throughout segments; cerci white.

Male.—Body about 3 millimeters long. Antennæ (Plate 1, fig. 12) with plumose hairs black; antennal ratio about 1.15; proportional lengths of distal six segments 23 : 24 : 90 : 58 : 45 : 54. Legs with trochanters all yellow, middle coxa brown, other coxæ yellow; claws slender, long, strongly arcuated, simple; proportional lengths of segments of hind leg 40 : 40 : 8 : 22 : 11 : 7.5 : 5; tarsal ratio of hind leg about 0.36. Wings (Plate 1, fig. 1) paler and narrower than in male, with anal area paler than other parts. Abdominal terga from first to fifth each subdivided into a pair of hemitergal plates. Hypopygium (Plate 1, fig. 15) black, without anal points; gonapophyses fused on basal half, bicuspidated and sharply pointed distally; styles almost as long as coxites, straight, pubescent on basal two-thirds, each with two blunt small teeth before distal end.

Locality.—Caroline Islands.

Holotype.—Male; Toloas-Erin, Truk Island; November 14, 1937.

Allotype.—Female, Malem, Kusaie Island; December 14, 1937.

Paratype.—Female, Malem, Kusaie Island; December 14, 1937.

This species is closely allied to *F. alboclavata* Kieffer, *F. hirtipes* de Meijere, and *F. biannulata* Ingram et Macfie. The first allied species, however, differs in the absence of scales on the legs and of white spots on the wings; the second species also differs in the absence of scales on the legs, and the third species is provided with a larger tarsal ratio of the hind leg, which is about 0.7.

LASIOHELEA PECTINUNGUIS de Meijere.

This ectoparasitic midge was first reported from Sumatra by Dr. J. C. H. de Meijere in 1923. The females were sucking blood from wings of *Miltochrista cruciata* Walker (arctiid) and *Simplicia margmata* Moore (noctuid). The specimens examined at this time were found on a sphingid moth collected at Kusaie. The male is unknown.

Female.—Body 1.2 to 1.5 millimeters long, wings about 1.1. Head including mouth parts brown, with eyes bare, broadly contiguous above. Maxillary palpi (Plate 1, fig. 16) 5-segmented (5 : 15 : 28 : 14 : 13); third segment very large, with sensillæ scattered on distal half of mesal side. Antennæ (Plate

1, fig. 7) with antennal ratio about 1.3; ultimate segment with a stylet pubescent; proportional lengths of distal eight segments 11 : 11 : 11.5 : 17.5 : 19 : 20 : 20.5 : 35. Thorax brown, slightly shining, with hairs yellow; mesoscutum with two pairs of yellowish-brown spots on anterior margin and with four brown subconfluent vittæ; caudoscutal area pale brown; scutellum yellowish brown; postscutellum dark brown; thoracic pleural and sternal sclerites yellowish brown; membranous areas yellow. Legs yellowish brown, with scales on tibiæ and tarsi; fourth tarsal segments squarely thickened; tarsal ratio of hind leg about 2.78; claws (Plate 1, fig. 13) slender, strongly angulated, with asymmetrical basal teeth; empodium large. Proportional lengths of segments 19: 19: 10: 3.5: 3: 2.7: 2.9 in foreleg, 23: 23: 9.5: 3.8: 3.4: 2.5: 2.5 in middle leg, and 24: 23: 12.5: 4.5 4: 2.5: 3.2 in hind leg. Wings (Plate 1, fig. 5) without colored markings, thickly hairy all over surface, with intercalary fork of cell R_5 distinct. Venation: Costa extending beyond middle of wing and slightly produced beyond end of Rs, first radial cell obliterated, second radial cell narrow and long, basal part of M_2 atrophied, fMCu slightly beyond base of second radial cell. Abdomen with tergal side pale brown, sternal plates yellowish brown, membranous areas yellow; cerci (Plate 1, fig. 21) discoidal, yellowish pale brown; spermathecæ (Plate 1, fig. 22) two, unequal, brown, short-oval.

Specimens.—Females; Lelo, Kusaie Island, Caroline Islands; November 30, 1937.

LASIOHELEA CAROLINENSIS sp. nov.

A small yellowish-white species with wings unadorned.

Female.—Body 1 to 1.2 millimeters long, yellowish in ground color. Head including antennæ and mouth parts brownish yellow. Thorax yellow, dull; mesoscutum with four yellowish pale-brown vittæ. Abdomen yellowish white. Legs yellowish white. Halteres white.

Head with eyes bare, contiguous above. Maxillary palpi (Plate 2, fig. 42) 5-segmented (6 : 14 : 13 : 10 : 11); third segment with scattered sensillæ. Antennæ (Plate 2, fig. 43) each with a terminal stylet; antennal ratio about 1.6; proportional lengths of distal eight segments 9: 9: 10: 19: 21: 22: 21: 27: 5. Mesoscutum yellow, with four yellowish pale-brown vittæ, of which median vittæ are short and subconfluent; scutellum yellowish white; other thoracic sclerites all yellow. Legs with slender scales; claws simple; empodium as long as claws; tarsal

ratio of hind leg about 2; proportional lengths of segments of hind leg 22: 22.5: 12: 6: 4.5: 3: 2.2. Wings (Plate 1, fig. 6) densely clothed with macrotrichia, intercalary fork in cell R_5 distinct. Venation: Costa hardly extending two-thirds of wing and barely produced beyond end of Rs, first radial cell linear, second radial cell very narrow and longer than thrice first radial cell (77 : 21), R_1 about one-third of Rs (30 : 100), base of M_1 and M_2 atrophied, M_1 angulated at middle, fMCu beyond base of second radial cell. Abdominal terga pale brownish yellow; spermatheca (Plate 1, fig. 19) one, almost spherical.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Female; Lelo, Kusaie Island; November 21, 1937.

Paratypes.—Females: Lelo and Malem, Kusaie Island; November 21 and December 14, 1937.

This species is somewhat allied to *L. tawana* Shiraki, *L. cubitalis* Kieffer, *L. lefanui* var. *squamipes* Ingram et Macfie, *L. stimulans* de Meijere, and *L. villosa* Macfie, which, however, differ in the following points: In the first allied species the eyes are pubescent, the maxillary palpi are provided with sensory pores, the legs are not provided with scales, and the color of the body is dark. In the second species the distal five antennal segments are longer, each being about two and one-half times segment nine. In the third species the wings are provided with bare areas along veins, and the body is dark brown. In the fourth species the antennal ratio is about 1.9, and the wings also have bare areas along veins. In the fifth species the tarsal ratio of the hind leg is about 1.8 and the antennal ratio is about 2.65.

PTEROBOSCA ADHESIPES Macfie.

This ectoparasitic midge has been often recorded from the tropical islands of the Pacific Ocean. The following species of dragon flies have been known as the hosts of this midge: *Lestes præmorsus* Selys, *Orthetrum sabina* Drury, *O. chrysis* Selys, *Raphismia bispina* Hagen, *Hemicordulia silvarum* Ris, and *Agrionoptera insignis allogenes* Tillyard. The specimens examined this time were collected at Ponape and Kusaie. The male is unknown.

Female.—Body 1.6 to 1.7 millimeters long; wing about 1.2. Head black; mouth parts brown. Thorax dark brown, with pleural and sternal sclerites brown, pleural membranes yellow. Legs brown, knee joints dark brown; coxæ brown. Wings without colored markings. Halteres white. Abdomen with ter-

gal plates yellowish brown, sternal plates dark brown, membranous areas yellow.

Eyes bare, broadly contiguous above. Maxillary palpi (Plate 1, fig. 8) 5-segmented (8 : 11 : 13 : 9 : 10), each with a large shallow sensory pore furnished with short sensillæ. Antennæ (Plate 1, fig. 10) dark brown, each with a terminal nipplelike process; antennal ratio about 2.53; proportional lengths of distal eight segments as follows: 7.5 : 7.5 : 19 : 21 : 22 : 21 : 23 : 34. Mesoscutum black, with brown pubescence; caudoscutal area brown, with a dark-brown median cloud. Legs without scales; tarsal ratio of hind leg varying from 3.5 to 4; fourth tarsal segments very short, usually shorter than half of fifth; tarsal claws absent; empodium very large, semicircular, with a pair of fleshy padlike lobes at base. Proportional lengths of segments as follows: 22 : 22 : 12.5 : 3 : 2 : 1.2 : 3.2 : in foreleg, 25 : 24 : 14 : 3.5 : 2.5 : 1.5 : 3 in middle leg, and 25 : 26 : 14 : 4 : 3 : 1.1 : 2.8 in hind leg. Wings (Plate 1, fig. 3) with macrotrichia thick; bare areas along veins distinct. Venation: Costa extending at middle of wing, first radial cell obliterated, second radial cell large and distinct, M_{1+2} forking just beyond r-m, but this forking is not clearly visible, the bases of two branches being deficient, fMCu under base of second radial cell. Abdominal segments from third to eighth each with sternal plate small, oval or cordiform; cerci (Plate 1, fig. 17) discoidal, dark brown; spermatheca (Plate 1, fig. 20) one, spherical, brown, with many hyaline scattered punctures.

Specimens.—Females; Kolonia-Nat, Ponape Island; November 19, 1937; Mwot-Utwe and Fwinkol, Kusaie Island; December 8 and 9, 1937.

PTEROBOSCA ESAKII sp. nov.

This ectoparasitic biting midge was found on the wings of dragon flies (Libellulidæ). Male unknown.

Female.—Body 1.4 to 2 millimeters long; general coloration black, shiny. Wings about 1 millimeter long, unadorned, with second radial cell very small but distinct. Halteres dark brown.

Head with eyes bare, broadly contiguous above with each other. Antennæ (Plate 1, fig. 11) dark brown; ultimate segment with a prominent terminal papillary projection; antennal ratio about 2.3; proportional lengths of distal eight segments 6 : 6 : 13 : 13 : 15 : 15 : 18 : 29. Maxillary palpi (Plate 1, fig. 9) 5-segmented (6 : 12 : 18 : 9 : 14); segment three with a sensory pore on distal part, its sensillæ invisible externally.

Thorax black, slightly shiny, with pleural membranes yellow. Legs dark brown; fourth tarsal segment very narrow, obliquely truncated; segment five square, thick, with claws slender and strongly curved; empodium (Plate 1, fig. 14) very large, with twelve or thirteen radial lobes and two pairs of plumose hairlike lobes at base; femora and tibiæ thickened; tarsal ratio of hind leg about 3.3. Proportional lengths of segments of legs 19 : 19 : 9 : 3 : 2 : 1.5 : 3 in foreleg, 22 : 22 : 10 : 3 : 2.5 : 1.5 : 3 in middle leg, and 23 : 22 : 10 : 3 : 2.5 : 1.5 : 3 in hind leg. Wings (Plate 1, fig. 4) oval, without scales, with macrotrichia not very abundant, with bare areas along veins distinct and broad. Venation: Costa extending about half length of wing, first radial cell obliterated, second radial cell well formed and as long as first cell, base of M_2 atrophied, fMCu beyond level of second radial cell. Abdomen with tergal and sternal sides black, slightly shiny, membranous areas dark yellow; spermathecæ (Plate 1, fig. 23), two, spherical, dark brown; cerci (Plate 1, fig. 18) brown, somewhat discoidal.

Locality.—Saipan Island, Marianna Islands.

Holotype.—Female; Charanka, Saipan Island; October 31, 1937.

Paratopotypes.—Females, October 31, 1937.

This parasitic midge is very closely allied to *P. ariel* Macfie, recorded from Boeroe Island, Moluccas, which differs, however, in the following points: The second radial cell of the wing is almost obliterated, the empodium of the leg consists of short radial lobes, and the tarsal ratio of the hind leg is 3.1.

ATRICHOPOGON FLAVELLUS Kieffer.

This species was recorded from the Philippines in 1921.

Female.—Body about 2.9 millimeters long, almost entirely yellow. Antennal flagellum pale brown. Mesothoracic scutum dull, clothed with brown setæ, with humeral spots yellowish white; four scutal vittæ yellow, of which median vittæ are shorter and paler than lateral; caudoscutal area whitish yellow; scutellum white. Wings unadorned, with veins yellow. Halteres whitish yellow. Abdominal terga yellowish pale brown.

Head with eyes bare, broadly contiguous above; proboscis shorter than vertical length of head. Antennæ each with a distinct sharp terminal stylet which bears two hyaline punctures; basal flagellar segments subspherical, with long sensillæ which are almost as long as antennal bristles; antennal ratio about 2.3; proportional lengths of distal seven segments 15 : 15 : 58 :

56 : 64 : 64 : 65. Claws of legs almost straight, each with a small preapical tooth; hind leg with proportional lengths of segments 48 : 46.5 : 33 : 12.5 : 8 : 4 : 5. Wings (Plate 1, fig. 25) with a distinct intercalary fork in cell R_5, broad bare areas along veins, and a veinlike stripe in cell M_2. Venation: Costa slightly produced beyond end of Rs and ending about three-fourths of length of wing, second radial cell about four times as long as first (35: 9), Rs about three and half as long as R_1 (43 : 12), base of M_2 narrowly atrophied, fMCu under middle of first cell and angle of fork very large, about 90°, Cu_1 strongly undulated. Cerci (Plate 2, fig. 40) yellow, discoidal; spermathecæ (Plate 1, fig. 41) oval, brown; basal area with many hyaline punctures.

Male.—Body about 2.8 millimeters long; coloration as in female. Head brown, with eyes broadly contiguous. Antennæ (Plate 2, fig. 34) with basal segments yellow, distal elongated segments and plumose hairs yellowish brown; proportional lengths of distal seven segments 26 : 23 : 22 : 35 : 120 : 87 : 127; antennal ratio about 1.5. Maxillary palpi 5-segmented (20 : 27 : 45 : 20 : 23); sensory pore of third segment with very short sensillæ. Legs with claws long, slender, bifid at tip; empodium very large; proportional lengths of segments 44 : 45 : 29 : 10 : 7 : 5 : 5 in foreleg and 55 : 54 : 39 : 16 : 10 : 5.5 : 5 in hind leg. Wings (Plate 2, fig. 24) without macrotrichia. Venation: Ratio of lengths between first and second radial cells 9: 32, that between R_1 and Rs 12: 41, stem of M_{1+2} very short or absent, fMCu under base of second radial cell and not widely differing from female, Cu_1 almost straight. Abdomen brown; hypopygium (Plate 2, fig. 35) brownish yellow; ultimate segment semicircular, without distinct cerci and anal points; coxites slender; styles shorter than coxites, almost straight, dark brown, each with a small preapical tooth; fused ectoparamere V-shaped, with median plate not pointed distally.

Specimens.—Males and females; Lelo, Kusaie Island, Paliker, Kolonia, Ponape Island, and Korror, Palau Island; November 21, 1937, and January 16 and 29, 1938.

DASYHELEA ESAKII sp. nov.

A yellowish white small species with dark-brown distinct markings. Femora and tibiæ of all legs each provided with a middle dark ring, the wing with a black distinct marking on the radial cell.

Female.—Body 1.3 to 1.8 millimeters long; ground color yellowish white, dull. Head yellowish brown. Antenna with scape yellow, pedicel and first flagellar segment white, segments from fourth to ninth yellowish brown, remaining five ultimate segments brown. Thorax with pronotum yellowish white; mesoscutum with three long brown vittæ which are separated from each other by two black lines on anterior area and by two elongated yellowish-white spots on caudoscutal area; anterior margin of these three vittæ dark brown; median vitta with a dark median line on anterior part, a large dark cloud on middle part, and two small black spots on posterior margin just before scutellum; lateral and anterior margins of scutum yellowish white, with two small black humeral spots on anterior margin and two small brown clouds on either lateral margin; thoracic pleural and sternal sides extensively brown, with several yellowish-white spots; one spot on posterior protergite, a lunate spot on sternepisternum above coxa, a similar spot on notepisternum and epimeron under base of wing, and a similar spot on membranous area under base of haltere. Wing with a very distinct square black spot on second radial cell. Halteres white. Legs mainly white; fore coxæ dark brown on both ends; middle and hind coxæ dark brown; knee joints and distal ends of all tibiæ black; tibiæ and femora of fore and middle legs each with a broad black ring at middle. Abdomen yellowish white, with lateral sides brown; abdominal terga from segments seven to nine each with a pair of dark-brown hemitergal plates; sterna of segments six and seven each with a pair of dark-brown spots; eighth sternum and cerci dark brown.

Eyes pubescent, broadly contiguous above. Maxillary palpi (Plate 2, fig. 39) yellow, 5-segmented (5 : 13 : 22 : 10 : 14); third segment with long scattered sensillæ on middle part. Antennæ (Plate 2, fig. 37) with proportional lengths of distal seven segments 12 : 12.5 : 14 : 16 : 16 : 15 : 21.5; antennal ratio about 0.76. Legs having proportional lengths of segments 20 : 18 : 11 : 3.5 : 2.5 : 2 : 2.5 in foreleg, 27 : 25 : 15 : 4.8 : 3 : 2 : 2.8 in middle leg, and 23 : 21 : 16 : 6 : 4 : 2 : 2.5 in hind leg. Wings (Plate 2, fig. 27) oval, with a square black spot on second radial cell, a faint brown cloud along costal margin beyond radial cells; macrotrichia rather scanty, spread on distal half of wing; bare areas along veins well defined. Venation: Costa ending at middle, first radial cell absent, R_1 and Rs being fused

with each other on basal part, second radial cell square, base of M_2 atrophied, fMCu under base of second radial cell.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Female; Lelo, Kusaie Island; November 21, 1937.

Paratopotypes.—Females; Lelo and Malem, Kusaie Island; November 21 and December 14, 1937.

This species is characteristic, being provided with specific coloration highly differing from other known species of the genus. The wings of *D. esakii* are somewhat similar to those of *D. pacifica* Macfie, recorded from the Marquesas Islands, but the coloration of the thorax and legs is quite different.

DASYHELEA INSULARIS sp. nov.

This species is black and shiny. The wing is provided with a brown spot on second radial cell. The haltere is white. Female unknown.

Male.—Body about 1.1 millimeters long. Head dark brown, with eyes hairy and contiguous above. Antennæ (Plate 2, fig. 33) dark brown; antennal ratio about 0.9; relative lengths of distal seven segments 12 : 12.5 : 12.5 : 23 : 30 : 31 : 24. Mouth parts also dark brown; maxillary palpi (Plate 2, fig. 32) 5-segmented (5 : 8 : 16 : 9 : 10), with scattered sensillæ on third segment. Thorax shiny, black; scutellum white; pleural membranes gray. Legs dark brown, with distal four tarsal segments somewhat paler; proportional lengths of segments of hind leg 17 : 18 : 10 : 5 : 4 : 2.5 : 2.5. Wings (Plate 2, fig. 26) with broad bare areas along veins. Venation: Costa ending before middle of wing, first radial cell absent, second radial cell obliterated, Rs squarely ending, fMCu beyond end of costa. Abdomen gray; terga and hypopygium brownish black; hypopygium (Plate 2, fig. 36) with points slender and each with a small terminal seta; coxites broad, short; style straight, non-pubescent on distal one-third; fused ectoparamere broad at middle, with an apical small spinelike projection.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Male; Malem, Kusaie Island; December 14, 1937.

This species is closely allied to *D. tersa* Johannsen, reported from West Java, which, however, distinctly differs in the following points: The eyes are not contiguous above but separated from one another by a fine line, and the proportional lengths of the distal six antennal segments are 16 : 38 : 30 : 25 : 25 : 46.

CULICOIDES KUSAIENSIS sp. nov.

This species is quite characteristic in possession of the unadorned wings which are provided with erect sparse macrotrichia, and reduction of the male antennæ which are not provided with plumose hairs and are incompletely segmented with less than 14 segments. The biting habits of the fly are unknown.

Female.—Body about 1.4 millimeters long, brown in ground color; wings uniformly fuscous, with veins brown, without colored markings.

Head brown, with eyes bare, very narrowly separated above; mouth parts brown, proboscis about half as long as head; maxillary palpi 5-segmented (4 : 10 : 15 : 6 : 9), with sensory pore of *obsoletus*-subtype. Antennæ (Plate 2, fig. 38) brown, 14-segmented, with antennal ratio 1.3 to 1.4; proportional lengths of distal eight segments 10 : 10 : 10 : 20 : 21 : 24 : 25 : 30 : 5. Thoracic tergum almost uniformly brown; mesoscutum with a pair of white humeral pits, a pair of pale-brown stripes on caudoscutal area, and a pair of pale obscure narrow stripes along pseudosutural foveæ; scutellum pale brown; thoracic pleural sclerites pale brown; other thoracic sclerites brown. Legs uniformly brown; fourth tarsal segments cylindrical; proportional lengths of segments of hind legs about 20 : 20 : 9 : 4.5 : 3.8 : 2 : 2. Wings (Plate 1, fig. 29) broad, oval, uniformly fuscous, without colored markings; macrotrichia short, erect, sparsely scattered almost all over surface of wing. Venation: first radial cell hardly as long as second, M_{1+2} very short, base of M_2 atrophied, fMCu far beyond fM_{1+2}. Halteres brown. Abdomen brown; sternal side pale brown; sternal plate subdivided at middle.

Male.—Body about 1.2 millimeters long. Antennæ without plumose hairs, 13-segmented at most, in extreme cases only 9-segmented, segments six to ten more or less fused; antennal ratio varying from 1.3 to 1.6; proportional lengths of distal three segments 37.3: 31.7: 35.7. Legs with relative lengths of segments 15 : 15 : 7.5 : 3.5 : 2 : 1.8 : 2 in foreleg, 19 : 19 : 9: 3.4: 2.5: 1.7: 2 in middle leg, and 18: 18: 7.5: 4.5: 2.5: 2: 2.5 in hind leg. Wings (Plate 2, fig. 28) with macrotrichia erect, very sparse; first radial cell very narrow, linear; M_{1+2} longer than in female; fMCu under fM_{1+2}. Sternal plate of each abdominal

segment narrowed at middle; hypopygium (Plate 2, fig. 30) brown, with anal points very short, blunt; fused paramere slender, bifurcated at end; gonapophyses strongly angulated, sharply pointed distally; styles slender, arcuated, as long as coxites, pubescent on basal half, pointed at end. Other structures and coloration closely as in female.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Male; Malem, Kusaie Island; December 14, 1937.

Allotopotype.—Female; December 14, 1937.

Paratopotypes.—Females; December 14, 1937.

This species is highly specific in the structure of the wing, and the male antennæ and differs extremely from the other known biting midges, as mentioned above.

CULICOIDES ARDENTISSIMUS sp. nov.

This species was taken at Malem together with *C. kusaiensis*. The coloration and structures of the body are very closely related to those of the preceding species. The male and the blood-sucking habits of the female are unknown.

Female.—Body about 1.7 millimeters long; head, thorax, and legs all reddish brown; wings without colored markings; halteres brown.

Head with eyes bare and very narrowly separated above; mouth parts reddish brown; proboscis slightly shorter than vertical length of head; maxillary palpi (Plate 2, fig. 31) slender, 5-segmented (8 : 23 : 28 : 9 : 12), each with a large sensory pore of *obsoletus* subtype consisting of short sensillæ. Antennæ with antennal ratio about 1.44; proportional lengths of distal seven segments about 12 : 11.5 : 24 : 25 : 28 : 29 : 34. Thoracic tergum reddish brown, shiny; mesoscutum with markings closely similar to those of *C. kusaiensis.* Legs with fourth tarsal segments cylindrical; claws each with a long basal seta; relative lengths of segments 21 : 21 : 10 : 4 : 2.5 : 2 : 2.8 in foreleg, 26 : 26 : 13 : 4 : 3 : 2.1 : 2.8 in middle leg, and 24 : 24 : 12 : 5.1 : 3.2 : 2.8 : 3 in hind leg. Wings with macrotrichia thickly spread over surface; two rows of macrotrichia extending basally between veins M and Cu_1; veins brown. Venation as in preceding species. Abdomen yellowish white; tergal and sternal plates reddish brown; sternal plates of first two segments atrophied; those of remaining segments each subdivided into one pair of small plates.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Female; Malem, Kusaie Islands; December 14, 1937.

This species is closely allied to *C. kusaiensis*, as stated already, but easily distinguished from the latter by the following characters: The general coloration is darker, the body is larger, the wings are provided with thicker macrotrichia, the maxillary palpi are longer and slenderer, and the proboscis is far longer.

CULICOIDES ESAKII sp. nov.

A very troublesome biting midge, severely attacking men, and very abundant at Ponape, Caroline Islands. Male unknown.

Female.—Body 0.78 to 1.1 millimeters long, yellow in ground color. Thorax shiny; anterior half of scutum with dark-brown markings; scutellum yellow. Wings 0.7 to 0.9 millimeter long, with large subconfluent clear spots, macrotrichia sparse on distal one-third. Halteres yellowish white.

Head brown on vertex, yellowish brown in frontal aspect; eyes separated from one another, as wide as diameter of an ommatidium. Antennæ (Plate 3, fig. 57) yellowish brown or brown; antennal ratio 1 to 1.2; proportional lengths of distal seven segments 9 : 8.5 : 8.5 : 12.5 : 13.5 : 15.5 : 21. Mouth parts pale brown; proboscis about half as long as head (38 : 70); maxillary palpi (Plate 3, fig. 53) 5-segmented (5 : 12 : 12 : 7 : 7); third segment with a sensory pore of *obsoletus* subtype. Thorax yellow, shiny; pronotum dark brown; mesoscutum dark brown on anterior half and with two pairs of circular lateral and a pair of large oval medial yellow spots on dark anterior area, yellow on posterior half and with a pair of dark-brown narrow lateral stripes and a brown median cloud on the yellow posterior area; scutellum yellow with a small brown median cloud; postscutellum black; pleural and sternal sides extensively yellow, with sternepisternum and notepisternum dark brown. Legs with coxæ, trochanters, femora, tibiæ, and basitarsi mainly brown, broadly yellowish white before and beyond knee joints; bases of femora narrowly yellowish brown; hind tibiæ very broadly yellowish white apically; distal four tarsal segments all pale brown; fourth tarsal segments cylindrical; claws simple; empodium vestigial. Proportional lengths of segments, except coxæ and trochanters, 76 : 71 : 36 : 13 : 10 : 7 : 10 in foreleg, 97 : 93 : 50 : 15 : 11 : 9 : 12 in middle leg, and 88 : 83 : 37 : 17 :

11 : 8 : 12 in hind leg. Wings (Plate 3, fig. 44) with adornment closely similar to that in *C. sigaensis* Tokunaga: first costal spot covering r-m and basal half of first radial cell, second spot covering distal one-third of second radial cell, second and third dark costal bands subequal in breadth, pale stripes along vein M_1; macrotrichia sparse, on distal one-third of wing, sometimes absent in cell M_4. Venation: first radial cell half as long as second, M_1 and M_2 slightly undulated, stem of Cu_1 also undulated, base of M_2 obsolete, fMCu slightly before or just under fM_{1+2}. Abdomen yellowish white, uniformly or broadly brown on lateral sides. Spermatheca (Plate 3, fig. 55) only one, yellowish brown, short oval.

Locality.—Ponape Island, Caroline Islands.

Holotype.—Female; Nampir-Sankakuyama, Ponape; January 3, 1938.

Paratopotypes.—Females; January 3, 1938.

This species is very closely allied to *C. orientalis* Macfie, from which it notably differs in possession of yellow spots on the mesoscutum. *C. gymnopterus* Edwards is also related to the present species, differing from it in the following characters of the wings: Macrotrichia restricted to less than a dozen at extreme tip of wing, second radial cell entirely pale, vein between R_1 and Rs absent. Japanese related species may be *C. maculatus* Shiraki, *C. sigaensis* Tokunaga, and *C. kyotoensis* Tokunaga, all very closely similar to the present midge in the coloration of the wings; the present midge is, however, highly characteristic in the following points of the wing venation: stem of Cu_1 distinctly undulated, fMCu located before or under fM_{1+2}. Besides the difference of the wing venation, in *C. maculatus* the sexual organ is provided with two spermathecæ and the basal flagellar segments of the antennæ are oval and elongated; in *C. sigaensis* the thoracic ground color is dark or reddish brown and the basal flagellar segments of the antennæ are also elongated and oval; in *C. kyotoensis* the legs are uniformly pale yellow, the thoracic ground color is brown, the scutum is provided with four vittæ, the scutellum is brown, and the basal flagellar segments of the antennæ are also elongated.

SERROMYIA ESAKII sp. nov.

A yellow species, somewhat related to *S. nudipennis* Kieffer, reported from Gallia. Male unknown.

Female.—Body 2.2 to 2.3 millimeters long, yellow in ground color. Head yellowish brown, with appendages brownish yellow. Thorax yellow, not shiny, setæ black; mesoscutum with three vittæ orange yellow; pleural and sternal sclerites yellow, with brownish clouds. Legs with coxæ and trochanters brownish yellow; other segments mainly yellowish white; fore and middle tibiæ with distal parts brown; hind legs with knee joints black; hind tibiæ broadly dark brown at base. Halteres white; knobs dark on marginal area. Wings without colored markings; veins hyaline and colorless. Abdomen white.

Eyes bare, narrowly separated above. Antenna (Plate 3, fig. 54) with a small preapical seta on base of blunt stylet; relative lengths of distal seven segments 14 : 14 : 24 : 27 : 31: 31 : 38; antennal ratio 1.2 to 1.3. Thorax without scutal spine on anterior margin. Fore and middle legs with fourth tarsal segments flattened, obliquely truncated; hind leg with femur thickened, with many (20) strong spinelike bristles on ventral side besides ordinary strong setæ; hind tibia strongly curved basally; first tarsal segments of all legs each with a basal and an apical spurlike bristle; those of forelegs each with three similar bristles on middle part; second and third tarsal segments of fore and middle legs each with one or two apical bristles; other tarsal segments without spurlike bristles; tarsal claws of fore and middle legs small, symmetrical; hind tarsal claws very unequal, relative lengths of paired claws 17 : 85; longer claw slender, very long, longer than fifth tarsal segment (85 : 50), with a small basal tooth; shorter claw simple; proportional lengths of segments of foreleg 30 : 28 : 15 : 6.5 : 4 : 2.5 : 4, those of middle leg 36 : 35 : 19 : 8 : 5 : 2.5 : 4, those of hind leg 49 : 38 : 20 : 11 : 8 : 6 : 8. Wing (Plate 3, fig. 45) with macrotrichia restricted to less than fourteen at margin of extreme tip. Venation: Costa ending at three-fourths of wing, relative lengths of first and second radial cells 11 : 19, of R_1 and Rs 14 : 30, r-m almost vertical and very short, M_{1+2} short, about thrice of r-m, fMCu under r-m.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Female; Malem, Kusaie Island; December 14, 1937.

Paratopotype.—Female; December 14, 1937.

This species is related to *S. nudipennis* Kieffer, but the latter is reddish brown or brown in ground color, the abdomen of the

female is brown, and the longer tarsal claw of the hind leg is only about thrice as long as the shorter one and about equal to segment five of hind leg.

CHIRONOMIDÆ

CHIRONOMUS DORSALIS Meigen.

A cosmopolitan species, widely distributed in the northern hemisphere. The specimens examined were collected from Truk and Kusaie Islands.

Male and female.—Body 4.5 to 5 millimeters long, yellowish white in alcoholic specimens. Head pale brown, with frontal tubercles pubescent. Male antenna with scape yellow, flagellum brown; antennal ratio 2.6 to 2.7. Female antenna 6-segmented (5 : 10 : 7.8 : 8 : 7.2 : 10.5), with a preapical seta. Mouth parts brown, with palpi 5-segmented (3 : 3 : 7.5 : 9.5 : 21 in male). Thoracic sclerites yellow; mesoscutum with three vittæ orange; postscutellum also orange. Legs yellow, with last tarsal segments brown; distal ends of all tarsal segments dark brown; foreleg ratio about 1.85 in male and 1.9 in female. Wings with veins yellow; r-m and base of Rs dark; anal margin very slightly constricted at end of Cu_1; in male fMCu slightly beyond r-m, R_{2+3} ending closely near by R_1. Abdomen brownish yellow, terga from second to fourth each with a dark median band. Male hypopygium as in Plate 3, fig. 61.

Specimens.—Males and females; Toloas-Erin, Truk Island and Lelo, Kusaie Island; November 14 and December 4, 1937.

CHIRONOMUS LONGILOBUS Kieffer.

This species was first described from Formosa by J. Kieffer. The specimens examined were collected at Toloas-Erin, Truk Island.

Male.—Body length 4 to 4.2 millimeters; ground color yellowish brown. Antenna with scape and pedicel yellow, flagellum brown, plumose hairs yellowish brown. Thoracic mesoscutum shining, with two median vittæ pale brown, two lateral vittæ brown; postscutellum brown. Legs pale brownish yellow; foreleg with knee joint broadly dark, distal end of tibia broadly dark, tarsus pale brown; middle and hind legs with knee joints narrowly dark, tibial end black only on tibial combs, tarsi yellowish pale brown. Wings with veins all brown even on crossvein. Halteres yellow. Abdomen yellowish brown; last two segments and hypopygium dark.

Head with frontal tubercles minute, spherical, bare. Maxillary palpi 5-segmented (2 : 2.7 : 6 : 9 : 12.5). Antennal ratio 1.74 to 1.96. Legs without beards; tibial combs each with a spur; leg ratio of foreleg 1.64 to 1.67. Wing with vein R_{2+3} ending before middle between ends of R_1 and R_{4+5}, fMCu beyond r-m. Hypopygium (Plate 3, fig. 60) with anal point basally setigerous, squarely truncated apically and thickened longitudinally on dorsal side; style short, somewhat oval, with a strong black spine at tip; dorsal appendage bare; ventral appendage slender, long, extending caudad as long as style.

Female.—Body 3 to 4 millimeters long; ground color pale brown. Antennæ yellowish brown; last segment brown. Four mesoscutal vittæ dark brown; postscutellum dark brown. Abdomen pale brown; last segment with sternum brown. Maxillary palpi 5-segmented (3 : 4.5 : 6.5 : 10 : 15.5). Antennæ 6-segmented (4 : 9 : 6 : 6 : 5.2 : 9.5), each with a preapical seta; segments three to five flask-shaped, each with a prominent neck region. Foreleg ratio 1.7 to 1.71. Wings 2.5 millimeters long; vein R_{2+3} ending one-fourth between ends of R_1 and R_{4+5}.

Specimens.—Males and females; Toloas-Erin, Truk Island; November 14, 1937.

CHIRONOMUS ESAKII sp. nov.

A pale brownish-yellow species.

Male.—Body about 4 millimeters long; thorax with four brown vittæ.

Head with frontal tubercles small; mouth parts brown. Antenna with flagellum brown, 12-segmented; antennal ratio 1.55 to 1.6. Thorax pale brownish yellow, with four scutal vittæ brown; postscutellum brown, with a pale median stripe; epimeral sclerites brownish yellow. Legs yellow; distal ends of tarsal segments and ultimate segments brown or dark brown; leg ratio of foreleg 1.6 to 1.7. Wings (Plate 3, fig. 46) with veins yellow, R_{2+3} extending closely along R_1, fMCu just beyond r-m, r-m without dark marking. Halteres yellow. Abdomen pale brownish yellow, ultimate two terga and hypopygium brown; ultimate tergum (Plate 3, fig. 51) highly setigerous on median area and sparsely setigerous on lateral sides, with anal point very prominent, forming a high ridge; coxite short; style very thickened, short, with a dorsal ridge, highly setigerous with very strong bristles on mesal area; dorsal appendage bare, fingerlike; ventral appendage with branched bristles.

Female.—Antenna 6-segmented (18: 48: 33: 37: 35: 60), without apical setæ. Spermathecæ yellow, spherical; other structures and coloration almost similar to those of male.

Locality.—Saipan Island, Marianna Islands.

Holotype.—Male; Charanka, Saipan Island; November 1, 1937.

Allotopotype.—Female; November 1, 1937.

Paratopotypes.—Male and female; November 1, 1937.

In coloration this species is somewhat related to *C. quadratus* Johannsen, recorded from Java, and in the structure of the male hypopygium to *C. grandilobus* Kieffer, recorded from Formosa.

PENTAPEDILUM ESAKII sp. nov.

A yellowish-brown species provided with four dark-brown vittæ on scutum.

Female.—Body 2 to 2.2 millimeters long. Mesoscutum not shiny, with four dark-brown vittæ; caudoscutal area brown. Legs with femoral end broadly faintly brown; tibiæ and tarsi pale brown; hind coxæ pale brown; other segments brownish yellow. Halteres white. Abdominal terga pale brown; caudal segments brown.

Head with eyes bare. Maxillary palpi 5-segmented (3: 2.3: 8: 10: 14.5). Antennæ 6-segmented (3: 6.8: 4.2: 4: 4: 7), each with two preapical setæ; intermediate flagellar segments each with a short neck region. Pronotum divided at middle, very narrow. Legs with claws, pulvilli, and empodia normal; foreleg with third tarsal segment barely longer than fourth (25 : 23); tibial combs one with a long and the other with a vestigial spur; foreleg ratio about 1.34. Wings (Plate 3, fig. 48) hairy all over, with bare areas along R_{4+5}, M_{3+4}, and Cu_1; costa not produced beyond end of R_{4+5}; R_{2+3} extending along R_1; fMCu beyond r-m. Abdomen short, swollen, oval; cerci somewhat ear-shaped, with blunt ventral projection.

Locality.—Kusaie Island, Caroline Islands.

Holotype.—Female; Malem, Kusaie Island; December 14, 1937.

Paratopotypes.—Females; December 14, 1937.

This species is related to *P. nodosum* Johannsen, recorded from Java, which, however, is provided with two reddish spots on either pleural sides of the thorax, has the longer ultimate segment of the antenna over twice the fifth, the elongated intermediate flagellar segments each of which bears a long neck region, the larger foreleg ratio about 1.7, and the long fourth tarsal segments of the foreleg far longer than the third (17 : 11).

PENTAPEDILUM TRUKENSIS sp. nov.

This species is provided with bicolorous scutal vittæ and cuneiform wings.

Male.—Body about 1.2 millimeters long. Head pale brown, eyes bare. Antennæ including plumose hairs brown. Thorax pale brown, mesoscutum with lateral vittæ dark, median vitta yellowish brown; postscutellum dark; pleural side with a dark stripe extending from neck to abdominal base. Legs yellowish white; femora very broadly dark brown on distal two-thirds; tibiæ also very broadly dark brown on basal three-fourths. Wings with veins brown. Halteres brownish white. Abdomen pale brown, posterior terga brown.

Antennæ 14-segmented, each with three apical setæ; ultimate segment equal in length to preceding eight segments taken together; antennal ratio about 0.7. Legs with pulvilli small; tibial combs one with a long and the other with a very short spur; fore tarsi broken off. Wings (Plate 3, fig. 47) cuneiform, with macrotrichia sparse, scattered almost all over; squama with two marginal setæ; venation: R_1 and R_{4+5} very widely separated at end, R_{2+3} extending along R_1, r-m very oblique, fMCu far beyond r-m. Hypopygium (Plate 3, fig. 59) with anal point very slender, clavate at end; styles slender, very long, twice or more longer than coxites; dorsal appendage very large, spherical, pubescent, with an apical hookletlike projection; ventral appendage clavate and curved dorsad at end, with a long preapical and many strong apical setæ on clavate end.

Locality.—Truk Island, Caroline Islands.

Holotype.—Male; Toloas-Erin, Truk Island; November 14, 1937.

This species is highly different from the known species of the genus, being provided with characteristic structures of the antennæ (small value of antennal ratio), the wing (cuneiform outline and widely separated R_1 and R_{4+5}), and the hypopygium (swollen dorsal appendages). The dark stripe of the pleural side of the thorax extending from the neck to the abdominal base is another distinct specific character to distinguish *P. trukensis* from the other *Pentapedilum* species.

TANYTARSUS HALOPHILÆ Edwards.

This marine species was recorded from a *Halophila* lagoon protected by a coral reef around the island of Samoa. The specimens examined at this time were mainly collected from Kusaie Island, and some of them were taken at light on the decks of a steamer lying about 300 meters from the island.

Male and female.—Body 1.5 to 2 millimeters long; ground color yellowish white. Male antenna with scape and pedicel white, flagellum pale brown; ultimate segment shorter than preceding three (40 : 50) but longer than preceding two segments taken together (40 : 35); antennal ratio 0.21 to 0.23. Female antenna 5-segmented (13.5 : 25.5 : 20 : 20 : 41.5). Maxillary palpi 5-segmented (5 : 10 : 42 : 47 : 74 in male and 7 : 8 : 33 : 38 : 60 in female). Mesothoracic scutum with a yellow median and two pale brownish-yellow lateral vittæ; postscutellum with two yellowish pale-brown clouds. Legs entirely yellow; leg ratio of foreleg of male about 1.76, that of female 1.7 to 1.8. Wings (Plate 3, fig. 52) with macrotrichia comparatively thick, fMCu beyond r-m. Male hypopygium (Plate 3, fig. 58) with anal point broad, flattened, setigerous; ventral appendage large, with many strong bristles; dorsal appendage elongated, with several setæ, its accessory lobe fingerlike, without setæ; ventro-proximal appendage relatively long, with tuft of simple setæ on distal part. Female cerci (Plate 3, fig. 64) elongated, slender, hardly thrice its width.

Specimens.—Males and female; Lelo and Malem, Kusaie Island; Caroline Islands; November 21 and December 14, 1937.

TANYTARSUS ESAKII sp. nov.

Very closely allied to the marine midges *T. halophilæ* Edwards and *T. maritimus* Edwards, recorded from the Samoa Islands and apparently marine in habitat, the females being provided with elongated cerci, which have been known only in marine species of the genus.

Male.—Body length about 2 millimeters; ground color almost entirely yellowish white; thorax with four brownish vittæ.

Head with eyes bare; no frontal tubercles. Antennæ 14-segmented, with plumose hairs rather scanty and pale brown; scape pale brown on basal half; ultimate segment shorter than preceding five, but longer than four segments taken together; antennal ratio about 0.4. Thoracic mesoscutum with four vittæ separated and brown or pale brown; median vittæ dark brown or brown on anterior half; postscutellum brown or pale brown. Legs yellow; leg ratio of foreleg 1.75 (1.6 to 1.9). Wings (Plate 3, fig. 49) with macrotrichia sparse; fMCu just beyond r-m, the latter very short. Hypopygium (Plate 3, fig. 62) without anal point; ultimate tergum with several setæ on caudomesal area; styles very broad; dorsal appendage with only four setæ, accessory lobe very small, slightly clavate, with two apical setæ;

ventral appendage comparatively slender, with setæ relatively sparse; ventroproximal appendage small, crowned with a tuft of simple setæ.

Female.—Body 1.4 to 1.5 millimeters long. Eyes reniform, widely separated above. Antennæ yellow, 5-segmented (10 : 26 : 16 : 17 : 32) ; ultimate segment pale brown on distal half or more, with two apical setæ; segments three and four fusiform, each with a short neck region. Maxillary palpi 5-segmented (8 : 10 : 30 : 35 : 60). Middle and hind tibiæ each with two combs which are widely separated and each provided with a spur. Wings (Plate 3, fig. 50) broader and more hairy than in male; bare areas along veins obscure. Ultimate sternum elongated, setigerous on caudal margin, with a small shallow caudal incision; cerci (Plate 3, fig. 63) elongated, pointed apically, about two and half times as long as wide; spermathecæ (Plate 3, fig. 56) yellow, spherical, with very short neck region.

Locality.—Ponape Island, Caroline Islands.

Holotype.—Male; Kolonia, Ponape Island; January 17, 1938.

Allotopotype.—Female; January 17, 1938.

Paratopotypes.—Males and females; January 17, 1938.

This species is very closely allied to the Samoan marine species *T. maritimus* Edwards and *T. halophilæ* Edwards. In *T. maritimus*, however, the wing is very sparsely clothed with macrotrichia: in the male wing the macrotrichia are a few around the tip and a row in cell R_5, in the female wing the macrotrichia are absent in the anal area, and the ultimate segment of the male antenna is shorter than the preceding three segments taken together. In *T. halophilæ* the third and fourth antennal segments of the female have no neck region and the hypopygium of the male is highly different in the structure of the ultimate tergum from the present species.

TANYTARSUS sp. No. 1.

This species is about 2 millimeters long and yellowish white in ground color. The mesothoracic scutum bears three pale-yellow vittæ.

Female.—Head without frontal tubercles; eyes bare, reniform, widely separated above. Maxillary palpus 5-segmented (3 : 2 : 6 : 8 : 11). Antenna 5-segmented (15 : 34 : 22 : 22 : 40) ; terminal segment with a preapical seta; segments three and four with neck region very short. Scutal vittæ pale yellow, median vitta paler than lateral; postscutellum pale yellow, with a median white stripe. Leg ratio of foreleg about 1.4; pulvilli

as long as claws. Wings hairy all over surface; costa not produced beyond end of R_{4+5}; fMCu slightly beyond r-m. Cerci very short.

Specimen.—Female; Malem, Kusaie Island; December 14, 1937.

This species seems to be identical with an undetermined *Tanytarsus* reported by Prof. O. A. Johannsen in 1932 from central Java.

TANYTARSUS sp. No. 2.

This undetermined species is very closely similar to *Tanytarsus* sp. No. 1. The body is almost entirely yellowish white, 1.8 to 2 millimeters long.

Female.—Head without frontal tubercles; eyes bare, reniform. Antenna 5-segmented (14 : 33 : 21 : 21 : 38), with an apical seta; third and fourth segments with neck region obscure. Mesothoracic scutum with lateral vittæ yellow, median vittæ dark brown; postscutellum dark brown, with a yellowish white median stripe. Fore tarsi broken off; pulvilli as in *Tanytarsus* sp. No. 1. Wings with macrotrichia numerous, all over surface, but sparser than in preceding species.

Specimens.—Females; Kolonia, Ponape Island; January 17, 1938.

BIOLOGICAL NOTES

By TEISO ESAKI

LASIOHELEA PECTINUNGUIS de Meijere.

Many females; Lelo, Kusaie Island, November 30, 1937.

This species was found on a sphingid moth, *Chromis erotus eras* Boisduval, which I captured at the edge of a window of my lodging house. The moth flew into the room the preceding evening, attracted by light, and was at rest when I discovered it, and I noticed at once that it was infested by a number of small midges. When I put the moth carefully into a killing bottle, nearly one half of the midges escaped from the body of the host before they were killed. No less than 30 specimens were found in all, and they were crowded on the forewings near the base and more sparsely on the dorsal surface of the thorax and of the basal part of the abdomen of the host. They crawled into the scales of the host, thus concealing the anterior parts of their body, and were undoubtedly sucking blood from the host.

PTEROBOSCA ADHESIPES Macfie.

Females; Kolonia-Nat, Ponape Island, November 19, 1937; Mwot-Utwe and Fwincol, Kusaie Island, December 8 and 9, 1937.

These minute midges were found exclusively on the wings of dragon flies. They were generally clinging to the veins near the base of the wings, and they escaped from the host when disturbed. In some specimens the abdomina were strongly swollen with blood from the host. The number of the parasites on a single host is rather small, ranging from one to three. The following dragon flies were observed as hosts of this midge:[1] From Ponape Island: *Tramea limbata* Desjardines, *Agrionoptera insignis similis* Selys, *Tholymus tillarga* Fabricius, *Hemicordulia* sp. No. 1; from Kusaie Island: *Tholymis tillarga* Fabricius, *Diplacodes bipunctata* Brauer, *Hemicordulia* sp. No. 2.

PTEROBOSCA ESAKII Tokunaga.

Females: Charanka, Saipan Island, October 31, 1937.

This midge was also found on the wings of dragon flies. The dragon flies occurring along the Charanka Lake, Saipan, were strongly infested by it, nearly every host bearing one or two midges, the maximum number of the parasites on a single host being 7. However, in other places in Saipan the midges were rarely observed.

The following hosts were ascertained: *Tramea limbata* Desjardines, *Pantala flavescens* Fabricius, *Tholymis tillarga* Fabricius, *Diplacodes bipunctata* Brauer.

CULICOIDES ESAKII Tokunaga.

Many females; Nampir, Ponape Island.

This very minute midge is well known among the natives and residents in Ponape, the natives calling it *amuinuel* or *em en uál.*[2] It is abundant and troublesome throughout forests in the mountainous regions in Ponape, attacking men in daytime. The annoyance caused by this midge is however much less severe than that of *Culicoides pelilouensis* Tokunaga of the Palau Islands, probably due to the more minute size of the midge, and no remarkable inflammation occurs after the infestation. The larval life of this midge is undoubtedly carried out in the streams.

TANYTARSUS HALOPHILÆ Edwards.

Lelo, Kusaie Island, November 21, 1937. Malem, Kusaie Island, December 14, 1937.

[1] Kindly identified by Mr. S. Asahina. [2] Gnats of the forest.

This minute midge was captured at light in the evening. In the former locality this species was captured with many other Diptera on board in the harbors of Kusaie. In Malem I observed a tremendous number of these midges swarming into the room.

TANYTARSUS ESAKII Tokunaga.

TANYTARSUS sp. No. 2.

Kolonia, Ponape Island, January 17, 1938.

These species were captured also at light in the evening. The former midge was found in a large swarm, as in the case of *Tanytarsus halophilæ* Edwards, observed at Malem, Kusaie.

FORCIPOMYIA ESAKIANA Tokunaga.

CHIRONOMUS DORSALIS Meigen.

CHIRONOMUS LONGILOBUS Kieffer.

PENTAPEDILUM TRUKENSIS Tokunaga.

Toloas Erin, Truk Island, November 14, 1937.

These species were collected by sweeping among the weeds.

CHIRONOMUS ESAKII Tokunaga.

Charanka, Saipan Island, November 1, 1937.

This species was also collected by sweeping among the weeds.

FORCIPOMYIA ESAKIANA Tokunaga.

LASIOHELEA CAROLINENSIS Tokunaga.

DASYHELEA ESAKII Tokunaga.

DASYHELEA INSULARIS Tokunaga.

ATRICHOPOGON FLAVELLUS Kieffer.

CULICOIDES KUSAIENSIS Tokunaga.

CULICOIDES ARDENTISSIMUS Tokunaga.

SERROMYIA ESAKII Tokunaga.

PENTAPEDILUM ESAKII Tokunaga.

TANYTARSUS HALOPHILÆ Edwards.

TANYTARSUS sp. No. 1.

Kusaie Island.

Of these several species the specimens from Lelo, November 21, 1937, were captured together with a great many crane flies of marine habitat, *Limonia* (*Idioglochina*) *kotoshoensis* Alexander, *Limonia* (*Dicranomyia*) *pectinunguis* Tokunaga, and *Limonia* (*Dicranomyia*) *pontophila* Tokunaga, on board at light in the harbor of Kusaie, about 300 meters off the islet Lelo.

Those from Malem, December 14, 1937, were also attracted by light in the evening, together with a large swarm of a minute chironomid, *Tanytarsus halophilæ* Edwards.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Forcipomyia esakiana* sp. nov., male wing.
2. *Forcipomyia esakiana* sp. nov., female wing.
3. *Pterobosca adhesipes* Macfie, female wing.
4. *Pterobosca esakii* sp. nov., female wing.
5. *Lasiohelea pectinunguis* de Meijere, female wing.
6. *Lasiohelea carolinensis* sp. nov., female wing.
7. *Lasiohelea pectinunguis* de Meijere, female antenna.
8. *Pterobosca adhesipes* Macfie, female maxillary palpus.
9. *Pterobosca esakii* sp. nov., female maxillary palpus.
10. *Pterobosca adhesipes* Macfie, female antenna.
11. *Pterobosca esakii* sp. nov., female antenna.
12. *Forcipomyia esakiana* sp. nov., distal segments of male antenna.
13. *Lasiohelea pectinunguis* de Meijere, fifth tarsal segment and claws of female leg.
14. *Pterobosca esakii* sp. nov., claw and empodium of female leg.
15. *Forcipomyia esakiana* sp. nov., male hypopygium.
16. *Lasiohelea pectinunguis* de Meijere, female maxillary palpus.
17. *Pterobosca adhesipes* Macfie, female cercus.
18. *Pterobosca esakii* sp. nov., female cercus.
19. *Lasiohelea carolinensis* sp. nov., spermatheca.
20. *Pterobosca adhesipes* Macfie, spermatheca.
21. *Lasiohelea pectinunguis* de Meijere, female cercus.
22. *Lasiohelea pectinunguis* de Meijere, spermathecæ.
23. *Pterobosca esakii* sp. nov., spermathecæ.

PLATE 2

FIG. 24. *Atrichopogon flavellus* Kieffer, male wing.
25. *Atrichopogon flavellus* Kieffer, female wing.
26. *Dasyhelea insularis* sp. nov., male wing.
27. *Dasyhelea esakii* sp. nov., female wing.
28. *Culicoides kusaiensis* sp. nov., male wing.
29. *Culicoides kusaiensis* sp. nov., female wing.
30. *Culicoides kusaiensis* sp. nov., male hypopygium.
31. *Culicoides ardentissimus* sp. nov., female maxillary palpus.
32. *Dasyhelea insularis* sp. nov., male maxillary palpus.
33. *Dasyhelea insularis* sp. nov., distal segments of male antenna.
34. *Atrichopogon flavellus* Kieffer, male antennal segments from ninth to twelfth.
35. *Atrichopogon flavellus* Kieffer, male hypopygium.
36. *Dasyhelea insularis* sp. nov., male hypopygium.
37. *Dasyhelea esakii* sp. nov., distal segments of female antenna.

FIG. 38. *Culicoides kusaiensis* sp. nov., female antenna.
39. *Dasyhelea esakii* sp. nov., female maxillary palpus.
40. *Atrichopogon flavellus* Kieffer, female cercus.
41. *Atrichopogon flavellus* Kieffer, spermatheca.
42. *Lasiohelea carolinensis* sp. nov., female maxillary palpus.
43. *Lasiohelea carolinensis* sp. nov., female antenna.

PLATE 3

FIG. 44. *Culicoides esakii* sp. nov., female wing.
45. *Serromyia esakii* sp. nov., female wing.
46. *Chironomus esakii* sp. nov., male wing.
47. *Pentapedilum trukensis* sp. nov., male wing.
48. *Pentapedilum esakii* sp. nov., female wing.
49. *Tanytarsus esakii* sp. nov., male wing.
50. *Tanytarsus esakii* sp. nov., female wing.
51. *Chironomus esakii* sp. nov., male hypopygium.
52. *Tanytarsus halophilæ* Edwards, male wing.
53. *Culicoides esakii* sp. nov., female maxillary palpus.
54. *Serromyia esakii* sp. nov., female antenna.
55. *Culicoides esakii* sp. nov., spermatheca.
56. *Tanytarsus esakii* sp. nov., spermatheca.
57. *Culicoides esakii* sp. nov., female antenna.
58. *Tanytarsus halophilæ* Edwards, male hypopygium.
59. *Pentapedilum trukensis* sp. nov., male hypopygium.
60. *Chironomus longilobus* Kieffer, male hypopygium.
61. *Chironomus dorsalis* Meigen, male hypopygium.
62. *Tanytarsus esakii* sp. nov., male hypopygium.
63. *Tanytarsus esakii* sp. nov., female cercus.
64. *Tanytarsus halophilæ* Edwards, female cercus.

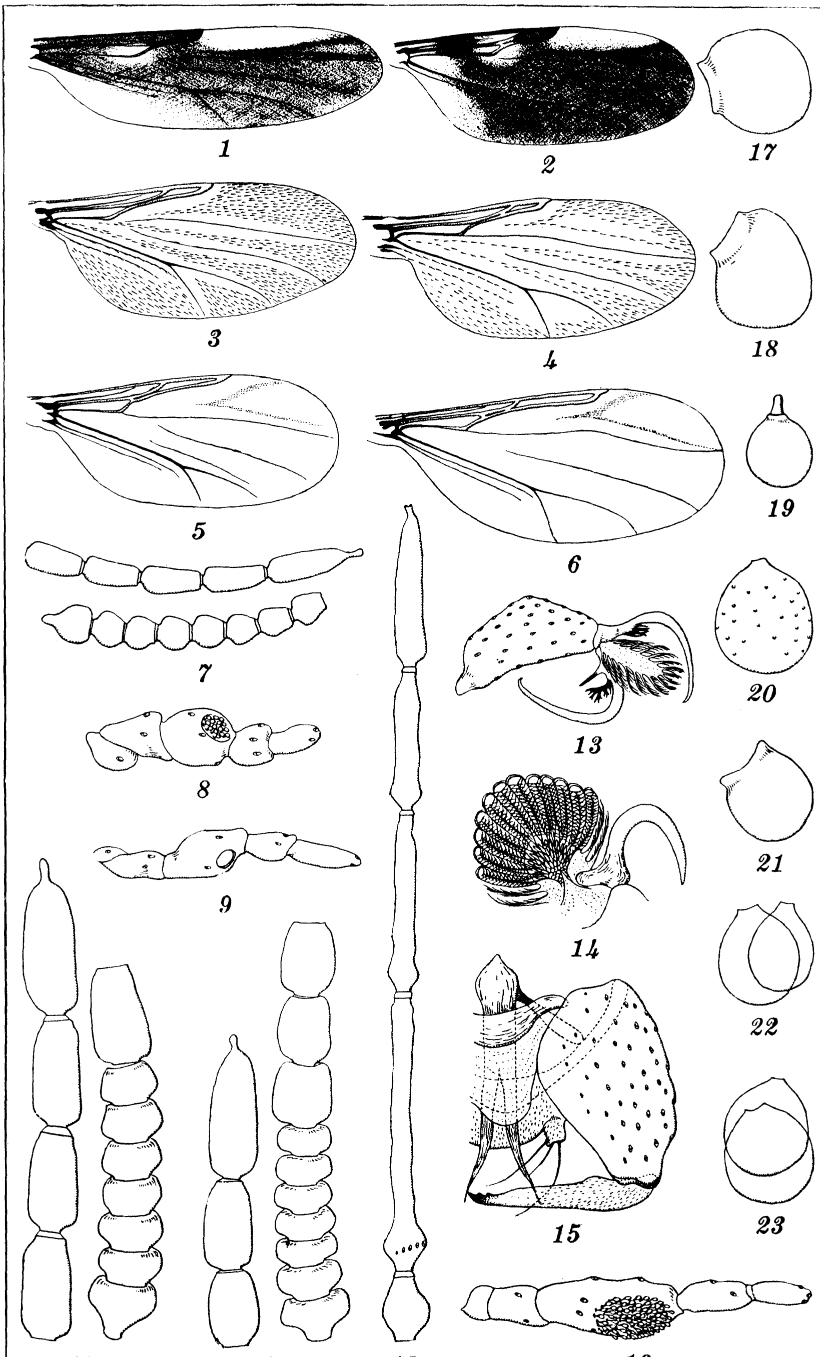

PLATE 1.

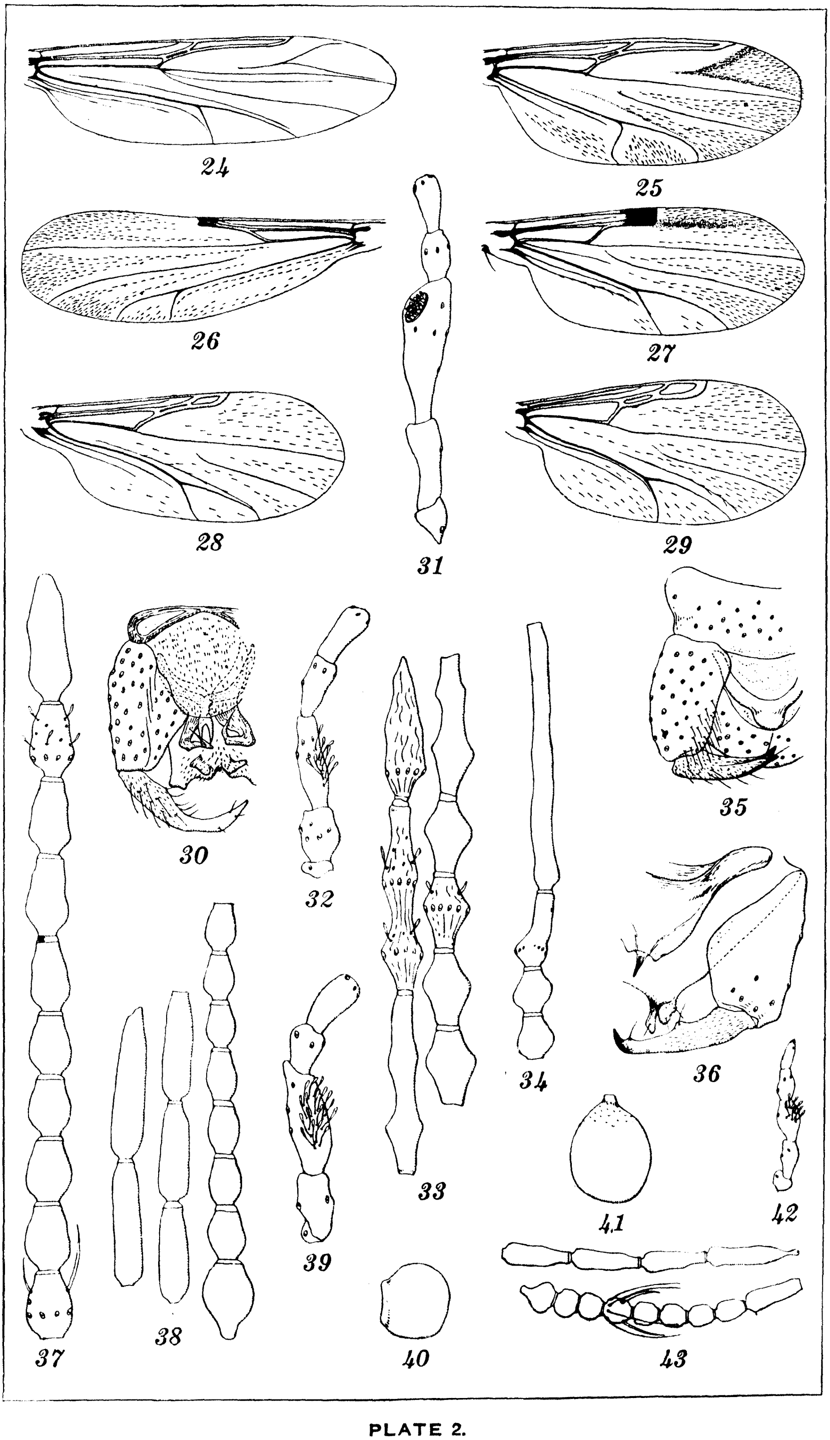

PLATE 2.

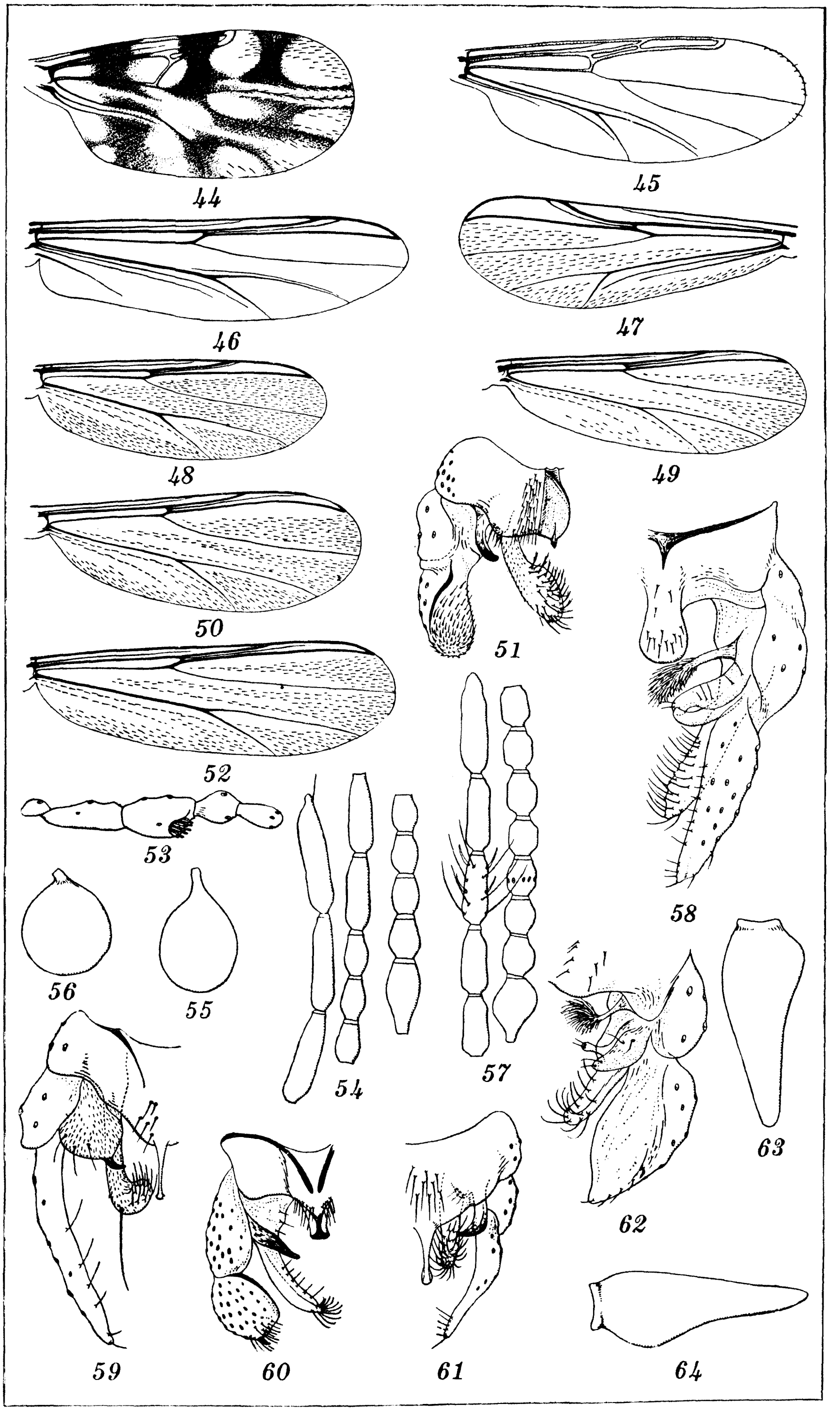

PLATE 3.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Childless. A Study of Sterility, Its Causes and Treatment. By Sam Gordon Berkow. New York, Lee Furman Inc., 1937. 307 pp., illus. Price, $3.

A book with a title like this one is often subject to superficial judgment. A perusal of the contents of the present book, however, convinces the reader that the author was guided by the most serious of motives. The subject is treated scientifically, yet its language is adapted to the potential lay readers, among which are about 2,000,000 childless couples in America alone, who need badly the information which it gives. The discussions on the so-called safe period theories are critical but sound. The fairly comprehensive bibliography at the end shows not only the thorough manner in which the author prepared himself before writing the book, but it is also a very useful guide to readers who may wish further light on any particular phase of the broad subject of sterility or childlessness.—C. R.

The Air and Its Mysteries. By C. M. Botley. With a foreword by Sir Richard Gregory. London, G. Bell and Sons Ltd., 1938. 296 pp., front., illus. Price, 8s/6d.

Of popular science books there is no end, and they run from good, through indifferent, to bad. Miss Botley's book is decidedly of the better class. It is not, as might at first be imagined, a popular treatise simply on the weather. Its scope is broader, covering in simple, entertaining fashion a host of interesting facts concerning our atmosphere, its constituents, its movements, its varied phenomena of sound and light, and other aspects. It has, in other words, the scope of a very general meteorology. The book is "crammed" with interesting facts and incidents; in fact, in endeavoring to pack as much as possible into a short space, the author's style at times becomes slightly cryptic or

obscure. But this is a very minor fault, and we willingly recommend this book to those who wish an up-to-date but popular account of our atmosphere and its ways.—C. E. D.

Child Psychology. By Noel B. Cuff. Louisville, Kentucky, The Standard Printing Co. Inc., 1937. 299 pp. Price, $2.50.

This book is intended as an elementary textbook in child study, based on results of experiments and investigations on child behavior. It utilizes the opinions of teachers of child psychology and outstanding books and research studies on the subject. It discusses in a clear-cut, brief, and pointed way the physical, emotional, and mental problems in every stage of child development. The organization is simple and flexible, hence adaptable to the particular needs of the teacher and the pupil. The presentation of the different units considers the viewpoints of several schools of psychology, especially the behavioristic and the gestalt schools. Emphasis is placed on facts so that beginners in the study of child psychology can readily get the principal points in the discussions. The principal features are the discussion questions, some simple experiments which may motivate the work, and objective test items at the end of each chapter. The selected references and references preferred by students will prove beneficial to the students.

The first chapter outlines the subject matter as gathered from a canvass of preferences of professors and students of child psychology, and the methods and objectives of a course in child study. Chapter II treats of the original nature of the infant, the theories of heredity and the prenatal influences, and enumerates some inheritable traits. Chapters III to VI discuss the physical and mental growth, the emotional development, and the nature and characteristics of the original tendencies as manifested in the different stages. A separate chapter is devoted to the problems and varieties of adjustment and the guidance necessary to develop an integrated child. The development of speech, the learning processes and meanings, and thinking and reasoning are clearly presented. The problems on socialization and guidance and the measurement and prediction of individual differences in mental ability are also discussed and should be very helpful to the student. The book should prove to be a suitable text in a course in child psychology.

—B. A. S.

Growth in Intellectual Ability as Measured by Repeated Tests. By Frank N. Freeman and Charles D. Flory. Monographs of the Society for Research in Child Development, Volume II, No. 2 (Serial No. 9). Washington, D. C., Society for Research in Child Development, National Research Council, 1937. 116 pp., illus. Price, paper, $1.

The purpose of this report is to supply evidence in support of conclusions formulated by psychologists and educators regarding intellectual growth and development. The study on which it is based covers a period of fifteen years, and was conducted by means of repeated tests. The tests and subjects used were well selected, a testing program was followed, and the findings were tabulated and interpreted. The V A C O—vocabulary, analogies, completion, and opposite tests, were used. The major problems were the rate of growth at successive ages or periods as expressed in the growth curve, the terminus of growth or the age at which it ceases or approaches zero in rate, individual and sex differences in these respects, and the relations between individual differences in level or degree of ability and differences in rate of growth or fluctuations in rate. According to the study, the curves of individuals, groups of individuals, or groups classified according to ability, vary from the average; the age at which intellectual growth ceases, for the group taken as a whole, is not earlier than nineteen (supported by tables and graphs); differences between sexes seem to be negligible, contrary to the common belief that intellectual growth of the two sexes differ because of the difference in rate of physiological development and of physical growth; individual differences in the rate of intellectual growth, especially in the fluctuations in rate and the form of the growth curve, are very significant. The findings are illustrated by tables and curves of distribution which are found throughout the pages of the report. At the end samples of the tests are given—vocabularies, analogies in different forms, sentence completion, and opposites.

The report will be very helpful to teachers of both psychology and child study and in the elementary schools.—J. C.

The Technical Analysis of Ores and Metallurgical Products. By Franklin G. Hills. 2d ed. rev. New York, Chemical Publishing co., inc., 1939. 250 pp., illus. Price, $3.

This book treats concisely both rapid and refined accepted methods of analysis, not only of usual ores and metallurgical

products but also of ores of rare occurrence. It contains discussions on careful selection of methods, interfering elements, dissolving of ores, and other analytical information not available in other similar text books.

The student as well as the experienced metallurgical chemist and engineer will find this a very handy guide and reference book in the laboratory.—R. A.

Soil and Human Health: A call to Action. By Edgar J. Saxon. London, The C. W. Daniel Company, ltd., n. d. 8 pp. Price, 3d.

This leaflet is a summary of an address the main theme of which is the soil as a factor in the maintenance of human health. The author brought out his theme through a brief discussion of the nature and function of the soil in providing man with his basic necessities for a healthful existence. His definitions of soil in general and what he calls "living soil" are very practical and intelligible. The account of man's endeavor to extract his daily bread from the soil, while brief, is instructive. The author emphasizes the importance of "ten radical requirements" in working out and treating the soil for sustained productivity which is very essential in the preservation of human health. He closes his summary with a concise but convincing exposition of the "disastrous pseudo-scientific blunders" which the author believes to be responsible for "widespread malnutrition, subhealth and disease" among the English people, and among all peoples.

The leaflet is highly informative and very interesting.

—Q. A. E.

Zur Entdeckung der Insulinschocktherapie bei akuten Geisteskrankheiten, Insbesondere bei der Schizophrenie. By Dr. Julius Schuster. Budapest, Pester Lloyd-Gesellschaft, n. d. 90 pp., illus. Price, paper, 2 Pengö.

The author puts forth and substantiates his claim (against Sakel) for priority relative to the insulin treatment of acute mental conditions, especially of schizophrenia, by citing his lecture given before the medical society in Budapest as far back as April, 1926. He deals at length with histopathological studies of the glia and nerve ganglion cells in various mental diseases. In schizophrenia the author believes that the essential and determining disturbance lies in defective metabolism of the phosphatides and related substances. Although clinical symptoms in schizophrenia strongly point to the thalamic region, no

histopathological changes were demonstrable there. A number of case records illustrate the result and successful effect of insulin treatment. In the concluding chapters of this interesting booklet the author discourses on laws of heredity and factors influencing it.—C. M. H.

Strange Animals and Their Stories. By A. Hyatt Verrill. Boston, L. C. Page & Company, 1939. 235 pp., front., illus. Price, $2.50.

This book is a popular account of strange forms and habits of a number of wild animals, the word "animal" being made synonymous with "mammals and quadrupeds" and not including birds, reptiles, fishes, shells, or other forms of lower animal life. Although based on scientific data and observations, the book is written in a popular form which makes it readily readable to persons without or with very little zoölogical background. To Philippine readers, students and scientific workers the book should be of interest because it sets forth phenomena which, perhaps, may be also true with a number of Philippine mammals. Although devoid of "juggernauts," as elephants, rhinoceros, hippopotamus, tapirs, and the like, the Philippines has a number of animals which may also be rightly called strange. Among these are the spiny ant-eaters, flying lemurs, tarsiers, civet cats, fruit bats, mouse deer, and tamarao. The author, who has many years of jungle experience with wild beasts, may find a number of strange things about the few mammals the Philippines has.—H. A. R.

Some Fundamental Aspects of the Cancer Problem. Symposium Sponsored by the Section on Medical Sciences of the American Association for the Advancement of Science, Atlantic City, New Jersey, December 29, 1936–January 1, 1937. Edited by Henry Baldwin Ward. Occasional publications of the American Association for the Advancement of Science. New York, The Science press, 1937. 248 pp., illus. Price, cloth, $2.50; paper, $2.

These papers constitute the symposium on cancer sponsored by the section of medical sciences of the American Association for the Advancement of Science, held at Atlantic City, New Jersey, from December 29, 1936, to January 1, 1937. There are 31 papers in all, classified under five different topics; namely, seven under heredity and constitutional factors, nine under induction, stimulation and inhibition of tumorous growths, five under metabolism of cancerous tissue, seven under radiation, and three under general discussion of the cancer problem. The most important of these papers are those bearing on the genetics

of cancer and its localization, and the factors of heredity, age, and acquired hypersensitiveness in relation to cancer; chemical aspects of the cancer work and the indications from chemical structures regarding the relationship between carcinogenic action and the sex hormones; production of tumors by chemical agents; relation of œstrin and other hormones to tumor formation in the breast; relation of protein metabolism to malignant growth; combined effects of Roentgen radiation and fever upon malignant tissue; recent progress in the study of radium poisoning; and changes and modifications in the conception of carcinoma. The latter group of papers brings out some facts borne out by rigid observations, which change our concept of carcinoma for the better, in the sense of enabling us to make an earlier diagnosis of the disease—C. R.

Comparative Psychology. A Comprehensive Treatise. Volume I. Principles and Methods. By Carl J. Warden, Thomas N. Jenkins and Lucien H. Warner. Psychology Series. New York, The Ronald press company, 1935. 506 pp., illus. Price, $4.50.

The first four chapters give a broad historical and theoretical approach to the viewpoint and problems of comparative psychology. A detailed discussion of the experimental methods of studying the behavior of the organism is effectively presented. Chapters V and VI offer in a logical and critical way the methods of testing the receptive and reactive capacities. The last chapter represents a comparative survey of the structure and function of the receptive, connective, and reactive mechanisms of living organisms.

The book should be a very effective textbook for students in advanced comparative and genetic psychology. It may also serve as a useful reference book in experimental psychology courses, the psychology of learning and physiological psychology. It is worded and written within the grasp of any intelligent person who is at all interested in and familiar with the subject.

—M. M. S.

RECEIVED

BOTLEY, C. M. The air and its mysteries. With a foreword by Sir Richard Gregory. London, G. Bell and Sons, ltd., 1938. 296 pp., front., illus. Price, 8s/6d.

Chemical analysis of aluminium and its alloys. London, The British Aluminium company, ltd., 1938. 85 pp., front., illus.

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JULIANELLE, LOUIS ALPHONSE. Etiology of trachoma. New York, The Commonwealth Fund, 1938. 248 pp., pl., map. Price, $3.25.

KOVACS, RICHARD. The 1938 Year Book of physical therapy. Chicago, The Year book publishers, 1938. 486 pp., illus. Price, $2.50.

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LEITH, C. K. Mineral valuation of the future. New York, published for the Seeley W. Mudd Fund, by the American institute of mining and metallurgical engineers, 1938. 116 pp. Price, $1.50.

SIMPSON, S. LEVY. Major endocrine disorders. Foreword by Sir Walter Langdon-Brown. London, John Bale medical publications, ltd., 1938. 184 pp., illus. Price, 10s/6d.

WHITLOCK, JOHN H. Practical identification of endoparasites for veterinarians. Minneapolis, Burgess publishing company, 1938. 37 pp., mimeoprint., illus. Price, $1.25.

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A REVISION OF THE GENERA OF ARTICULATED CORALLINES

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TWENTY PLATES

The articulated corallines, a group of red algæ (Rhodophyceæ), belong to the more highly organized Florideæ. Kylin,(15) in his first treatment, includes Corallinaceæ under the order Cryptonemiales. This order is characterized by the presence of typical auxiliary cells which are arranged in specialized filaments and differentiated prior to fertilization. In the different families of the Cryptonemiales the reproductive system varies in structure and distribution. In the Corallinaceæ the carpogonial branches and auxiliary filaments are assembled in differentiated nemathecia on the surface of the frond and enclosed by peritheciumlike protective coverings, in this group usually called conceptacles. Corallinaceæ is divided into two sections, Corallineæ and Nulliporeæ;(11) Corallineæ and Melobesieæ(13, p. 259) are distinguishable by the presence of segmented or jointed erect fronds in the Corallineæ and their absence in the Nulliporeæ or Melobesieæ. The segmentations are made up of the alternation of uncalcified with calcified segments, respectively called genicula and intergenicula. The alternating segments likewise differ in structure in various degrees in different genera and different species. The erect fronds of the articulated corallines seem to arise always from crusts or horizontal thalli, like in some species of Melobesieæ. The erect articulated fronds

arising from these crusts are branched in various ways, and the segments are of different shapes. The reproductive organs have been found only on the segmented fronds. There are three kinds of reproductive bodies known in Corallineæ; namely, tetrasporangia, cystocarps, and antheridia, each of which is borne in a special receptacle or conceptacle. The three corresponding kinds of conceptacles are borne in similar positions on the erect fronds but on different individuals, except in *Jania* (*Jania rubens*) where the cystocarpic and antheridial conceptacles have been found in the same individual.(30, p. 99)

From the foregoing it appears that the positions of the conceptacles, the structure of the genicula and of the intergenicula, the modes of branching, and the shapes of the articuli differ, and the combination of these characters can probably be used to draw lines of generic distinction. These variations will be examined in detail before their relations to generic cleavage are discussed.

MORPHOLOGY

THE CRUSTS

According to available records, the early stages of the development of articulated corallines are crustaceous expansions, or horizontal thalli, designated as "crusts." Harvey seems to be the first to give an account of the crustaceous stage in the articulated corallines, particularly in *Corallina officinalis* Linn., which he describes as:—"root, a widely spreading calcareous crust."(11, pl. 222) Thuret(30, p. 100) observes that when the spores of *Jania rubens* germinate, hemispherical structures are first developed from which arise the erect segmented fronds. Yendo(37, p. 7) emphatically states that the embryonal stage of the Corallinæ is a mere incrustation upon a substratum, from which arise the erect segmented fronds. Rosenvinge(27) likewise states that the articulated fronds of *Corallina officinalis* are given off from a basal crust, very much like in some crustaceous Lithothamnia. Oltmanns(25, p. 269) emphasizes that in the development of Coralineæ (citing *Jania rubens* as an example) crusts are first developed from which arise the segmented fronds. In the species of *Corallina, Calliarthron,* and *Bossea,* which have been observed under natural conditions on the Pacific Coast, particularly in the Moss Beach region of Central California Coast, the early stages of their development appear as orbicular lobed crusts from which later evolve the erect segmented fronds. The crusts reach a diameter of approximately

2 cm, but in several instances they are of greater diameter. In the latter cases they are made up of two or more crusts fused together, with the fusion margins readily detectable. In *Corallina officinalis*(27) the crust attains a diameter of 2.4 cm.

Our knowledge of the microscopic structure of the crusts is very limited. According to available records, Rosenvinge is the only worker who has made investigations along this line, but he merely described the structure of the crust of a single species, *Corallina officinalis.* The crust is made up of 3 layers: a hypothallus of long cells arranged in a horizontal direction; a perithallus of ascending filaments of shorter cells; and a layer of nondividing cover cells, perhaps in interrupted continuity. Unfortunately a complete account of the crusts of all the species of the articulated corallines is impossible, because the only crusts available are those of species of *Corallina, Calliarthron,* and *Bossea,* on the accessable parts of the California Coast. The crusts in all these genera are likewise made up of three layers, the epidermis, the perithallus, and the hypothallus. The epidermis is a layer of rectangular thick-walled cells, covering the surface of the older portions of the crusts, first appearing several cells from the growing margins in species of *Corallina* and *Bossea,* and one layer or more of the same type of cells in species of *Calliarthron,* likewise covering the older portion of the crust to within several cells from the margin. The epidermis of the crust of the species of *Calliarthron* is a single layer towards the margin and two or more layers on much older portions of the crust. The marginal regions of the crusts of the species concerned are covered by a distinct continuous structureless membrane. These marginal regions are made up of flabellate meristematic tissue differentiated to some extent into a hypothallus and a perithallus. By the growth of the hypothallus and of the perithallus the crust increases both in diameter and in thickness; this development will be taken up more in detail in the near future, when material becomes available, in connection with the study of the comparative anatomy of the crusts of the different species of the articulated corallines.

The hypothallus is made up of several layers of horizontal long-celled filaments which branch radially and in their turn produce filaments that curve upwards and outwards, constituting the perithallus, the cells of which are comparatively very much shorter than those of the hypothallic filaments, and the length of the cells of which gradually decreases towards the periphery.

The filaments and the cells of the hypothallus and of the perithallus are arranged in a fashion similar to that of the intergenicula of the genera and species to which they belong, the structure of the perithallus and of the hypothallus, respectively, resembling the structure of the intergenicular cortex and medulla of their genera and species. In species of *Corallina* and *Bossea*, for example, the hypothallic filaments are straight and parallel, and the cells are to some extent arranged in uniform transverse zones, while in species of *Calliarthron* the filaments are flexuous and interlacing, and relatively very much shorter than those of the species of the other genera. The crust of *Calliarthron*, in addition, is about three or four times as thick as that of the species of *Corallina* and *Bossea*. These structural differences suggest that the structure of the crusts of the other genera (*Amphiroa, Arthrocardia, Jania, Cheilosporum, Metagoniolithon, Pachyarthron*, and *Joculator*) also varies with the corresponding variations of the structure of the intergenicula, a point of inquiry that will be taken up later when sufficient material becomes available for investigation in conjunction with the projected study of the comparative anatomy of the crusts of the different species of the articulated corallines.

In certain species of Melobesieæ the crusts are made up of a distinct hypothallus, perithallus, and epidermis or cover cells arranged in such a way as to resemble the structure of the crusts and of the intergenicula of certain species of the articulated corallines.

The reproductive organs of the more highly developed species of the Melobesieæ are incased in special receptacles (conceptacles) comparable to those of the articulated corallines, and situated in or on their horizontal thalli, or, in certain species, on erect unsegmented protrusions of the horizontal thallus. In the articulated corallines the conceptacles have only been found on special erect protrusions of the horizontal thallus comparable to the Melobesieæ, except that in the articulated corallines the receptacle-bearing structures are segmented into alternating calcified and uncalcified segments respectively designated as intergenicula and genicula. These similarities in the structure of the thallus and of the reproductive organs, and in the localization of the reproductive organs in certain species of the Melobesieæ to those of the articulated corallines, suggest a generic relationship between the Melobesieæ and the articulated corallines, whichever direction evolution may have progressed. In a sense

the articulated corallines may be thought of as species of the Melobesieæ in which the reproductive organs are borne only on the more highly specialized structures, the articulated fronds.

THE GENICULA

The uncalcified segments of the erect fronds were called "genicula" by Areschoug (3, pp. 529–561) and "nodes" by Weber van-Bosse. (32, pp. 86–101) In this account the term *genicula* will uniformly be used. According to Yendo (37, p. 26) "the formation of the geniculum takes place at an early period of the development of the frond, and the first geniculum is already perceptible when the process of the frond has reached 1 mm above the incrustation." In *Corallina officinalis* (27, p. 270) the articulated fronds are connected with the crusts by the genicula. In species of *Corallina, Calliarthron,* and *Bossea* that have been investigated in this study, the basal genicula are likewise developed in the early stages and are recognizable at the earliest appearance of the erect fronds on the surface of the older portions of the crusts. In the species that have been investigated the basal genicula are the first permanent structures developed. They arise from the hypodermal layer of the perithallus, and their development may be traced as follows: certain cells of the hypodermal layer of the perithallus elongate to a length characteristic of the species; then short segments are marked off at distal ends of the elongated cells. The lower segments become the basal geniculum of the erect frond, and the upper segments become a flabellate meristem which gives rise to succeeding alternating calcified and uncalcified segments (respectively designated as intergenicula and genicula). In the articulated corallines there are two sorts of genicula, the unizonal and the multizonal. The unizonal genicula are represented in certain species of *Amphiroa,* and in all species of *Corallina, Cheilosporum, Duthiea, Arthrocardia, Bossea, Calliarthron, Jania, Joculator, Pachyarthron,* and *Lithothrix,* while the multizonal genicula are characteristic of most species of *Amphiroa* and all the species of *Metagoniolithon.* In *Lithothrix* the genicular cells are several times shorter than those of the intergenicular medullary cells, while in species, with unizonal genicula, the genicular cells are slightly longer than those of the intergenicular medullary cells. Unfortunately the development of only a few species of the latter group has been traced, but it may be that, in the case of multizonal genicula, the genicular primordia un-

dergo transverse division into the number of zones characteristic of the species. According to Yendo (37, p. 28) and Oltmanns (25, pp. 267–271) the primary genicula of the branches develop in a way similar to those of the basal genicula of the main fronds. The basal genicula and the primary genicula are (in the sense of our interpretation) both perithallic in origin and arise very close to the apical meristem of the structure concerned. On the other hand, the secondary genicula are medullary in origin (or hypothallic in our sense) and arise in regions several rows of cells below the growing apex. (37, pp. 26, 27) In the early stages of their development the genicula are not completely differentiated and are still completely corticated. As development progresses, the cells of the genicular primordia elongate and become thick-walled in unizonal genicula, but in the case of the multizonal genicula the cells of the genicular primordia undergo transverse division into the number of zones characteristic of the species. This process is accompanied by cell elongation of the various zones and thickening of the cell walls, a process during which the cortex remains unchanged and consequently is subjected to great pressure by the enlargement of the cells of the inner tissue. At a certain stage, however, the cortex is unable to withstand the internal pressure and consequently is ruptured. In many instances the broken cortex persists unchanged, particularly in species with unizonal genicula, so that the genicula remain uncorticated, while in other instances, particularly in species with multizonal genicula, the inner layers of the disrupted cortex become meristematic and regenerate a cortex which completely envelopes the genicula. The genicula proper, even where they are unizonal, are comparatively much longer than the individual rows of cells of the intergenicular medulla, the only exception being those of the species of *Lithothrix*, in which they are many times shorter than the individual rows of cells of the medulla.

The cells of the genicular tissue are thick-walled, appearing almost polygonal in cross section. (37, p. 18) In species with unizonal genicula (except in *Lithothrix*), the cells have thin-walled tapering ends, referred to as "extragenicular portions" with the sectors between these tapering ends with much thickened walls. The characteristic tapering ends of the genicular cells have not been observed in multizonal genicula and in *Lithothrix*, suggesting that the cells in the development of the multizonal genicula do not undergo so much differentiation. This suggestion is supported by the fact that, in general (except in thickness of the

walls), the cells of the multizonal genicula are closely similar to those of the intergenicular medulla in the same species.

While Yendo(37) definitely describes marked variations in the genicular structure, he seems to ignore the value of such structures in outlining the taxonomy of the articulated corallines. Mme. Weber van-Bosse,(32) on the other hand, emphasizes the fundamental value of such structures in taxonomy. She calls attention to the fact that the genicula of the species of *Amphiroa* and *Metagoniolithon* are multizonal, while those of *Corallina, Jania, Arthrocardia, Lithothrix,* and *Cheilosporum* are unizonal. She further emphasizes the fact that the successive rows of cells of the genicula of *Amphiroa* are unequal in length. From a study of the genicular structure of a very large number of species of the articulated corallines, collected from the Pacific coast of North America, and obtained from herbarium materials from other parts of the world, made available through the courtesy of different European herbaria, there has been found strong indication of the value of the varying structure of the genicula in attempts to make more clear the taxonomy of this group. All the species of *Corallina, Arthrocardia, Calliarthron, Cheilosporum, Pachyarthron, Jania, Bossea, Joculator,* and *Duthiea* have long unizonal genicula; *Lithothrix* has comparatively short unizonal genicula; and most species of *Amphiroa* and all species of *Metagoniolithon* have multizonal genicula of varied structure.

THE INTERGENICULA

In the foregoing pages it has been pointed out that the crusts give rise to erect fronds with regular alternating calcified and uncalcified segments. The calcified segments have been called articuli,(2, 3, 10, 12, 21, 38) joints,(8, 32) and articulations, (16; 17, pp. 266–292) but in this account the term intergenicula will be used consistently.

Like the geniculum, the intergenicular primordium appears as a flabellate structure or rows of flabellate meristematic cells. In *Amphiroa*(32, p. 81) this meristem is covered on the outer surface with cover cells (Deckzellen); in *Metagoniolithon* it is covered with a thick, structureless, cuplike membrane very closely similar in outline, but not in structure, to the root cap of flowering plants; in the other genera this meristem is merely externally covered with a very thin structureless membrane. In the formation of the intergenicula(32, p. 81) the cells of the central portion of the meristem merely divide transversely, forming cells of the medulla, while the cells of the peripheral regions undergo

both transverse and oblique divisions. The cells resulting from the latter divisions are pushed sideways, and by subsequent transverse and longitudinal divisions lateral tissue (cortex) is formed.

After the basal geniculum of the erect frond is formed, the development of the succeeding intergenicula and genicula follows in regular order. The basal intergenicula are always cylindrical, but those of the upper portions of the erect fronds vary in shape in the different genera as well as in the different species, and also in the different portions of the fronds of the same species. In *Jania, Pachyarthron, Metagoniolithon,* and in a number of species of *Amphiroa* the intergenicula are cylindrical or subcylindrical. In *Calliarthron* as a rule most of the intergenicula are compressed, but those of the species with stunted growth have the tendency to be cylindrical, and in other species the branches likewise end in extensions made up of cylindrical intergenicula. The compressed intergenicula vary in form from almost rectangular-oblong and cuneate to obcordate, with lobes obtuse or acute in species of *Amphiroa, Corallina, Cheilosporum, Bossea, Calliarthron,* and *Joculator.* The variations in shape of the intergenicula have been used by a number of authors in their generic and specific distinctions in the taxonomy of the articulated corallines, so that they will be taken up again in connection with the taxonomic account of this group.

According to available literature the internal structure of the intergenicula of a large number of species has been deemed worthy of particular attention. Thuret(30) states that the frond of *Corallina* (citing *C. officinalis* as an example) consists of central filaments the cells of which are long and arranged in zones of equal length, and that the cortical filaments are produced by lateral branching from these central filaments. According to Areschoug(3) and Ardissone(2) the intergenicula are made up of cortical and interior tissue, the cortical tissue consisting of subspherical cells and the interior tissue of ellipsoidal or filiform cells arranged in transverse zones. Yendo in his figures(36) shows that the intergenicula of species of *Amphiroa* are made up of a cortex of almost isodiametric cells, and a medulla of rows of long and rows of short cells alternating in a variable pattern. Weber van-Bosse,(32) in speaking of *Amphiroa,* states that, "the branches whether ascending or spreading horizontally, have all a central strand of elongated cells and a cortical layer of isodiametric or ellipsoidal cells." In a large

number of species of the articulated corallines investigated, the intergenicula are made up of epidermis (or a layer of cover cells), cortex, and medulla. The epidermis is made up of a single layer of rectangular thick-walled cells.

The cortex consists of filaments whose cells decrease in length towards the periphery. These cortical filaments are arranged almost parallel to one another except in *Calliarthron,* where the cortical filaments are flexuous and interlacing. In a considerable number of species of the different genera, the cortical filaments radiate obliquely from the medulla, while in *Pachyarthron, (Pachyarthron cretaceum), Lithothrix (Lithothrix aspergillum),* and in some species of *Amphiroa,* these filaments appear directly perpendicular to the medulla, so that in the latter cases the medulla and the cortex are very distinctly differentiated from one another.

Of the three tissues of the intergenicula, the medulla exhibits a great variety of structural variations in the different genera and in the different species. The medulla of all the species of the different genera investigated is made up of filaments whose cells are arranged in zones or rows. The medulla of *Lithothrix* is merely a single horizontal rows of long cells. In *Calliarthron* the medullary filaments are flexuous and interlacing. The medullary filaments in all species of *Amphiroa* are straight and parallel, with cells in long and short zones alternating in various ways. In the other genera the medullary filaments are likewise straight, but the cells are in zones of uniform length.

Yendo(36) definitely illustrates marked variations in the medullary structure of various species of the articulated corallines, but he seems to belittle the value of such structures in the segregation of the different genera. Weber van-Bosse,(32) on the other hand, emphasizes the fundamental value of such structures in her attempt to segregate the different genera. She points out that the intergenicular medulla of *Amphiroa* is made up of straight filaments with rows of short cells and rows of long cells alternating in various ways, depending upon the species, while in *Corallina, Jania, Arthrocardia, Cheilosporum,* and *Metagoniolithon* the medullary filaments are likewise straight, but the cells are in rows of equal length; in *Lithothrix* the medulla is merely a single zone of long cells. Yendo(38) later finds marked structural variations in the intergenicular medulla, but considers such structural variations as of little generic value, using them only in making distinctions between his different sections of the

genus *Amphiroa*. In a study of the structure of a very large number of species of the articulated corallines, collected from the Pacific coast of North America and obtained from herbarium materials from other parts of the world, made available through the courtesy of the different European herbaria, there have been found not only profound structural variations of the intergenicula, of the medulla in particular, but also their value in a more logical generic segregation within the group of the articulated corallines than visualized even by Dr. Weber van-Bosse. Summarizing, species of *Amphiroa* are made up of straight and parallel filaments and zones of long and short cells variously alternating; in *Corallina, Bossea, Cheilosporum, Pachyarthron, Arthrocardia, Duthiea, Joculator,* and *Metagoniolithon* the medullary filaments are likewise straight and parallel, but the cells form zones of uniform length; in *Calliarthron* the filaments are flexuous and interlacing; and in *Lithothrix* the medulla is merely a single horizontal row of long cells.

THE BRANCHES

In the earlier part of this account it was pointed out that the erect segmented fronds arising from the crusts, as growth proceeds, soon cease to be simple, but branch, the branches likewise becoming segmented and arranged in various fashions in the different genera and in the different species. To these branches various designations have been given, *rameux,*(5, p. 63; 17, pp. 266–292; 30) branches,(10, 27, 32) *rami,*(2, 3) *zweige,*(13) and *aeste,* 25, p. 269) but in this account the designation branches (English equivalent of the other terms) will be used consistently.

The branches are made up of genicula and intergenicula, or structures structurally comparable to the genicula and intergenicula and showing structural expressions of the main erect fronds. The number of genicula and intergenicula that constitute a branch varies in different genera and in different species. In *Corallina* and *Bossea,* for example, a branch may be made up of a single geniculum and an upper segment, intergenicular in structure, which, in certain species of *Corallina,* serves as the sole bearer of the reproductive organ, the conceptacle. In the majority of cases it may itself repeatedly branch, producing a pinnate or even bipinnate or pinnately decompound structure in certain species of *Corallina, Bossea, Calliarthron* and *Joculator;* verticillate or dichotomous-verticillate in *Metagoniolithon;* dichotomous in *Amphiroa;* dichotomous or dichotomous-cymoid in *Jania;* irregular in *Pachyarthron* and in *Lithothrix;* and pin-

nate-cymoid in *Arthrocardia* and *Duthiea*. In general, in species of *Corallina, Bossea, Calliarthron,* and *Joculator*, the fronds are distichous, with branches either opposite, alternate, or subalternate, depending on the species. In *Corallina* (*Eucorallina*) *armata* Hook. f. et Harvey, (10, p. 103, pl. 40, figs. 1–7) however, the fronds are partly distichous and partly polystichous, on account of simple ramules arising on the flat surfaces on the upper ends of certain intergenicula. In *Corallina* (*Cornicularia*) *Cuvieri* Lamouroux (17, p. 286, pl. fig. 8, *a*, *b*) the primary branches are distichous and opposite, while the branchlets are dichotomous. In certain species of *Metagoniolithon* [*Metagoniolithon charoides* (Lamx.) Weber van-Bosse] (32, p. 102) the branching is entirely verticillate (polystichous), while in other species [*Metagoniolithon gracile* (Harvey) Yendo] (38, p. 12) the branching on the lower parts is verticillate (polystichous), on the upper parts strictly dichotomous. In *Lithothrix* primary branching is dichotomous and secondary branching spiral.

According to available literature, the mode of development of branches in the articulated corallines has not been traced to any considerable extent. Yendo (38, p. 27) merely states (citing *Amphiroa fragilissima* and *A. valonoides* as examples) that

> The primary stage of the ramules is a mamillary process on the surface of the articulus. It is built up with a number of layers of globular or rectangular cells not distinguishable from the cortical cells. As the process elongates upwards by intercalary growth of the cells of one or more layers, the geniculum is transformed from one of the elongated cell layers.

Oltmanns (25, pp. 269–271) gives only an account of the early stages of development in *Corallina*, when certain cells of the medullary filaments elongate and, after attaining a certain length, short segments are marked off at the distal ends, the lower segments becoming the geniculum and the upper segments, the flabellate meristem. In this study of the development of the branches it has been found that the branches arise always on the upper portions of the intergenicula, except in the following three sets of cases: in *Metagoniolithon* they arise from any portion of the cortex of the genicula; in certain species of *Amphiroa* and in the case of the secondary branches of *Lithothrix*, they arise from any portion of the side (cortex) of the intergenicula. Normally, and where they arise from the upper portion of the intergenicula, the branches are medullary in origin, while in the special three cases just mentioned they are cortical in origin. In a large number of species, particularly those with regular dichotomous branching, the branches are developed from the apical

meristem. Prior to the development of the branches, the growing apex has a conical or semicircular shape. In the early stage of the development of the branches certain regions of the apical meristem become less active than the other regions, resulting in the formation of lobes, two in dichotomous, three in pinnate, four or more in extreme cases. In certain instances these lobes elongate considerably prior to the development of the genicula, so that the branches appear as if borne on stalks. In the development of a branch or upper segments in species with unizonal genicula, certain cells of the apical meristem elongate considerably, and short segments are marked off at the distal ends, the lower segments becoming the geniculum and the apical segments the flabellate meristem. The cells of the central region of the apical meristem elongate vertically and divide merely by transverse division, producing the rows of cells of the medulla, while the cells of the lateral regions elongate obliquely and divide both longitudinally and transversely, producing the cortical tissue. The development of the branches in species with multizonal genicula is essentially the same as that of the species with unizonal genicula, except that in the former case the apical meristem undergoes several transverse divisions in the production of the genicula.

In what may be considered the usual or normal cases, the branches arise directly from the growing apices as first described, but in *Metagoniolithon* they arise from the subepidermal layer of the genicular cortex; in *Lithothrix* the secondary branches arise from the extreme inner layer of the intergenicular cortex, and in certain species of *Amphiroa* they arise from the subepidermal layer of the intergenicular cortex. In these three special cases the branches arise from seemingly matured tissue. In the early stage of development in these three special cases, certain seemingly matured cells of the tissue concerned become meristematic, producing branch primordia which undergo development in a fashion similar to that described as the normal procedure.

A number of authors (cited below in connection with taxonomy) have made clear the value of the differences in the modes of branching in attempting a logical classification of the articulated corallines. A study of the modes of branching of a large number of species of the different genera brought out indications of their importance in the segregation of the different genera, and likewise in the segregation of the different species.

In *Corallina* (*Corallina officinalis*) and in certain species of *Bossea* (*Bossea plumosa*) the branching is pinnate; in *Jania* (*Jania rubens*), *Cheilosporum* (*Cheilosporum sagittatum*), and in most species of *Amphiroa* (*Amphiroa fragilissima*), the branching is definitely dichotomous; in *Metagoniolithon* (*Metagoniolithon charoides*) the branching is verticillate; in *Lithothrix* (*Lithothrix aspergillum*) the main branches are dichotomous, but the branchlets are not uniform in their arrangement; in *Corallina Cuvieri* and in *C. corniculata* (14, pls. 69, 70) the primary branches are truly dichotomous, while the branchlets are arranged pinnately; in *Arthrocardia* and *Duthiea* the branching of the sterile fronds is pinnate but cymoid when fruiting; in *Pachyarthron* the branching is composite, dichotomous, or irregular-dichotomous.

LIFE HISTORY

The life history of the articulated corallines has never been traced chronologically and completely for any one of the known species, but indications seem to prove beyond doubt that it is essentially similar to that of *Corallina officinalis* var. *mediterranea*, studied by Yamanouchi.(34) According to this author, the life cycle of this species involves three types of plants, the tetrasporic, cystocarpic, and antheridial, all similar to one another. Unfortunately, however, Yamanouchi was unable to follow through the life cycle. His culture plants reached only the early crustaceous stages. From the tetraspores he was able to study only 13-celled crustaceous plants, and 17-celled crustaceous plants from the carpospores. From the relative number of chromosomes, however, his inferences are that the carpospores germinate into tetrasporic plants and the tetraspores into sexual plants (cystocarpic and antheridial). The carpospores have forty-eight chromosomes (2n) and the tetraspores, twenty-four chromosomes (n), reduction taking place in the first division in the formation of tetrads. Unfortunately it has not been possible in this study to carry through any cultures, and judgment along the lines of relations between the different stages of development is possible only through their comparison, framed through extensive collections of plants growing in nature. From general observations on species represented on the coast of California, particularly on various species of *Corallina* and *Calliarthron*, there is no apparent difference in the microscopic structure of the fronds (genicula and intergenicula) between the sexual and asexual plants. In size, under practically the

same conditions, however, the sexual plants appear very much smaller than the asexual plants. In the genera not represented on the coast of California only the tetrasporic plants have been available. The inference seems borne out by general experience that the sexual plants of all genera are probably very much smaller than the asexual plants.

In 1878 Thuret(30, p. 93) observed that the three types of reproductive organs in *Corallina officinalis* var. *mediterranea* are borne on three different sets of individuals. In *Jania rubens,* however, the cystocarpic and the antheridial conceptacles are found in the same plants, and the tetrasporic conceptacles on different individuals.(30, pp. 99, 100) In the species collected on the coast of California no cases of monœcism were detected. Differences in shape of the different kinds of conceptacles (tetrasporic, cystocarpic, and antheridial) were observed in *Jania rubens* and in *Corallina officinalis* var. *mediterranea* by Yamanouchi.(34) In our specimens collected from the coast of California these differences in shape of the different kinds of conceptacles are likewise detected. In species of *Corallina* the antheridial conceptacles are more elongated than the tetrasporic conceptacles, and the apices are attenuated. Of this species, tetrasporic and antheridial plants only were collected, so that nothing can be said about the shape of the cystocarpic conceptacles. In species of *Calliarthron,* such as *Calliarthron cheilosporioides* and two others published in another paper, the tetrasporic conceptacles are semiglobular, the cystocarpic conceptacles conical with blunt apices, and the antheridial conceptacles likewise conical but with attenuated apices. From these indications it is highly possible that in the species of the other genera only the tetrasporic stages of which are known at present, the different kinds of conceptacles (if they produce likewise those different kinds of conceptacles) have likewise different shapes.

THE CONCEPTACLES

The reproductive organs of the articulated corallines are borne in a receptacle called *conceptaculum,*(6, 32) *ceramidium,*(10; 11, pl. 222) *keramidium,*(3) conceptacle,(30, pp. 94–96) and *Konceptakulum;*(13; 25, p. 365) in this account the designation conceptacle (plural, conceptacles) will be used uniformly.

The development of the conceptacles of the articulated corallines, judging by available records, has not been traced to any

considerable extent. All published accounts along these lines have dealt merely with a single species (*Corallina officinalis*). According to Thuret,(30) the early stages of the development of a conceptacle of *Corallina officinalis* consist of the inhibition of the growth of the central region of the apical meristem of a branch, accompanied by decalcification and the gelatinization of the cell walls of the central tissue, followed by the sloughing off of their cuticular covering. While these activities are going on, the filaments of the peripheral regions remain meristematic, growing up and producing the enclosing conceptacle wall. From the tissue at the base of the cavity of the conceptacle thus formed the reproductive organs arise, whether tetrasporangia, carpogonia, or antheridia. In the formation of the tetrasporangia the basal cells of the conceptacle produce vertical club-shaped protrusions which undergo transverse divisions forming the tetraspores. The antheridia in *Jania rubens* (L.) Lamouroux,(28, p. 543, fig. 288) in *Corallina mediterranea* Areschoug, (25, p. 365, fig. 3) and in *Calliarthron cheilosporioides* Manza(22, p. 46) arise not only from the bases of the conceptacles but also from the inner sides of the conceptacular cavities. These indications lead to the inference that the development and origin of the antheridia in all species of the articulated corallines are similar. The early stages of the development of the antheridia are closely similar to those of the tetrasporangia, except that the vertical protrusions are very much slenderer. In the development of the sperms the protoplasm collects at the distal ends of the protrusions, accompanied by slight swelling of those apices. Ultimately the walls dissolve, setting free globular structures (sperms) each provided with a polar flagellumlike structure consisting of the cytoplasm that has not been used up in the formation of the sperm proper. Thuret does not seem to have followed the stages of the development of the cystocarps to any considerable extent. He merely states that the basal filaments of the conceptacles give rise to the trichophoric apparatus of cylindrical cells. All these cells divide transversely, the basal segments remaining short, forming carpogonia, while the terminal segments elongate, forming the trichogynes. The carpospores arise from the carpogonia situated at the periphery of the trichophoric system. The formation of carpospores consists of the elongation and swelling of the carpogonial cells accompanied by transverse division, the apical segments undergoing

further successive divisions (two or three), forming segments which becomes spherical, which later are set free as carpospores. Yamanouchi (34) merely states:

Generally the conceptacles are formed at the ends of the branches of the thallus. The reproductive organs, which arise within the conceptacles originate from the so-called disk cells which compose the central portion of the growing apex of each branch. The disk cells located at the periphery continue to divide and grow around the reproductive organs leaving only small aperture or ostiole at the apex, thus forming the conceptacle. The 3 kinds of reproductive organs (tetraspores, antheridia, and carpogonia) are produced in conceptacles on 3 different individuals.

In the formation of the tetraspores the disc cells divide into two, the lower segments forming the stalk cells, the upper, the tetraspore mother cells. The tetraspore mother cells elongate and become club-shaped, accompanied by two successive nuclear divisions, the first being heterotypic, the second, homotypic, and followed by transverse wall formation, resulting in the formation of the tetraspores. The disc cells, in the formation of the male reproductive organs, likewise divide into two, the basal segments forming the stalk cells, the upper, the antheridia. The antheridia elongate and the nuclei divide once. One of the daughter nuclei in each antheridium migrates to the apex and the other migrates towards the base, followed by transverse wall formation between the two nuclei. The apical cells enlarge and become spherical; these are set free as spermatia. In the formation of the female reproductive organs the disc cell undergoes transverse division, the lower segment forming the stalk cell, the upper segment, the auxiliary cell. The auxiliary cell, in turn, gives rise to two lateral cells, only the older one of which becomes functional. This older cell elongates and the nucleus divides into two nuclei one of which remains in the swollen base to constitute the carpogonial or egg nucleus, while the other moves to the tapering upper portion of the cell, the trichogyne, and functions as a trichogyne nucleus. The early stages of the development of the cystocarp consist in the fusion of the sphermatium and the egg, accompanied by the fusion of the auxiliary cells (numbering 60 to 70 in each conceptacle) resulting in the formation of a large central cell. The fertilized nuclei then migrate to the central cell and arrange themselves along the periphery. Each of the sporophyte nuclei divides once, forming two daughter nuclei, one of which remains in the central cell while the other migrates to the lateral process produced by the

central cell. The cells on the surface of the central cell undergo repeated transverse division, forming chains of cells which enlarge and become spherical. These cells are finally set free as carpospores.

In my own study of the early stages of the development of the conceptacles of a large number of species of the different genera, I found two types of development: the *Corallina* type of conceptacular development, and the *Amphiroa* type of conceptacular development. To the *Corallina* type belong the conceptacles of species of *Corallina, Jania, Joculator, Duthiea, Arthrocardia, Cheilosporum, Calliarthron,* and *Bossea,* while to the second group belong those of the species of *Lithothrix, Amphiroa,* and *Metagoniolithon.* In *Calliarthron* and *Bossea* the conceptacles are not developed on the actively meristematic regions of the branches, but rather on the seemingly matured intergenicula. In the beginning of the development of the conceptacles in these two genera certain cells of the outermost layer of the intergenicular cortex become actively meristematic, dividing transversely and thereby producing a peripheral layer of cells which soon becomes thick-walled. This layer serves as a protective covering of the conceptacular primordium. After this initial stage the subsequent stages are closely similar to those found in the other genera of this group of the *Corallina* type, which in turn are closely similar to that described by Thuret(30) for *Corallina officinalis,* except that prior to the development of the reproductive organs, whether tetrasporangia, carpogonia, or antheridia, the basal tissue of the conceptacular cavity undergoes development forming parenchymatous tissue from which arise the reproductive organs.

As in the cases of *Calliarthron* and *Bossea,* the conceptacles of *Amphiroa, Lithothrix,* and *Metagoniolithon* arise from the seemingly matured cortex of the intergenicula. In the early stages of the development of the conceptacles in the latter three genera a layer of cells of the intergenicular cortex, situated one or more layers below the epidermis, becomes meristematic, while the surrounding layer or layers of cells remain inactive. The cells of this meristematic layer elongate radially, the cells of the central region elongating more rapidly than the cells of the peripheral regions, thus producing emergences on the surfaces of the intergenicula. The elongation of the meristematic cells forces the nonmeristematic layer or layers of cells to rupture, the apical regions of the emergences thus creating an opening. The cells

at the region of breakage become meristematic, undergoing mostly radial division, thus producing the ostiolar portion of the conceptacle. In these three genera it appears that the basal tissue of the conceptacle becomes directly the propagating tissue.

The stages of the development of the reproductive organs in various plants studied by me have not been traced consecutively, but indications show that they are the same throughout the whole group and follow the stages described by Thuret and Yamanouchi for *Corallina officinalis.* As has been stated in conjunction with the life history of this group, the three kinds of conceptacles (tetrasporic, cystocarpic, and antheridial) have thus far been found only in certain species of *Corallina, Calliarthron,* and *Jania,* while the accessible materials of the other genera (*Amphiroa, Lithothrix, Metagoniolithon, Pachyarthron, Arthrocardia, Cheilosporum, Duthiea, Joculator,* and *Bossea*) have thus far provided only tetrasporic conceptacles. The reproductive organs, except the antheridia, arise from the bases of the conceptacular cavity, except in *Duthiea Setchellii* and certain species of *Arthrocardia* (which are described in another paper), where the tetraspores have been found to arise both from the base and the wall of the conceptacle. As has been reported, the tetraspores are in transverse zones within the tetrasporangium. The antheridia are slender, club-shaped filaments, each giving rise to one spermatium with a polar flagellumlike structure, resembling that reported by Thuret in *Corallina officinalis.* The appendage, according to Thuret, is not a motile organ, but rather a part of the cytoplasm which has not been completely consumed in the formation of the spermatium proper.

Several authors (cited below in conjunction with the taxonomy of this group) have emphasized the fundamental value of the varying positions of the conceptacles in distinguishing the different genera of the articulated corallines. This indication has been confirmed in my own study of a large number of species of the group. In *Corallina, Jania, Arthrocardia,* and *Duthiea* the conceptacles are practically all terminal or apical; in *Joculator,* both terminal and lateral; in *Cheilosporum,* on the upper margins of the wings of the intergenicula; and in *Calliarthron, Amphiroa, Pachyarthron, Bossea, Lithothrix,* and *Metagoniolithon,* they are scattered over the surfaces of the intergenicula.

In connection with the position of the conceptacles, we have applied the terms terminal and lateral.(22, pp. 45, 47) Terminal conceptacles are found, as indicated, in all species of *Corallina,*

Jania, Arthrocardia, Duthiea, Joculator, and in certain species of *Calliarthron,* while lateral conceptacles are found in all species of *Amphiroa, Bossea, Lithothrix, Cheilosporum, Calliarthron, Pachyarthron,* and *Joculator.* Schmitz and Hauptfleisch,(28, p. 540) however, seem to have a different viewpoint in regard to the interpretation of the conceptacles being terminal, when they emphatically designate the conceptacle of both *Corallina* and *Cheilosporum* as terminal. In *Corallina,* for example, the conceptacles are borne on the apices of the segments. They arise from the apical meristem, and in their development the entire apical meristem is used up, terminating the axial growth of the segments. Conceptacles developed in this fashion are practically upright, except in *Duthiea* where they are slightly tilted sideways. To these conceptacles the term "terminal conceptacles" is applied. In the case of *Amphiroa,* on the other hand, the conceptacles are borne on the seemingly matured portions of the segments. They arise from the cortex, and appear as lateral projections on the segments. To the conceptacles borne in this fashion the term "lateral conceptacles" is applied.

In dealing with the positions of the conceptacles (*a*) their origin and (*b*) their position relative to the axes of the segments from which they arise are to be considered. Terminal conceptacles are those on the apices of the segments and springing from the apical meristem; and the lateral conceptacles are those on the sides of the segments and springing from the seemingly matured tissue. In a sense, likewise, terminal conceptacles are primary in origin while the lateral conceptacles are secondary in origin, since the former spring from the apical meristem and the latter from the seemingly matured tissue (by secondary meristem).

HISTORICAL SKETCH OF THE GENERIC CONCEPTIONS

According to available records, a number of the articulated corallines were known and studied as early as the middle of the 18th century, but no attempt was made to segregate them among the different genera. All species known about that time were referred merely to a single genus, *Corallina,*(7, 8, 21) a genus likewise including other calcified algæ such as species of *Halimeda* (green algæ) and *Galaxaura* (red algæ). In the early part of the 19th century, however, great interest arose in the taxonomy of the algæ, and from this time on to the early part of the 20th century a number of works dealing with the genera

of the articulated corallines were published. Lamouroux, in 1812(16) and 1816,(17) established three genera of the articulated corallines distinguished primarily by the modes of branching: *Amphiroa,* with branching dichotomous or verticillate and the "articuli" separated by cushions of an opaque and horny substance; *Corallina,* with branching trichotomous; and *Jania,* with branching dichotomous. Decaisne in 1842(6, pp. 119–125) adopted the three genera established by Lamouroux, but further distinguished *Cheilosporum* and *Arthrocardia* as subgenera of the genus *Amphiroa.* In his account he placed particular emphasis on the position of the conceptacles in distinguishing the three genera: *Corallina,* with terminal conceptacles and with irregular branching; *Jania,* with conceptacles provided with two or four horns of ramuli and with branching either pinnate or dichotomous; and *Amphiroa,* with conceptacles scattered over the surfaces of the articuli. Areschoug(3) recognized 5 genera by elevating *Cheilosporum* and *Arthrocardia* (the two subgenera of Decaisne) to generic rank in addition to three genera already established, recognizable thus: *Amphiroa,* with terete-filiform, subterete, compressed or flat fronds; with branching di- or trichotomous or "dichotomo-verticillata;" with the cortical cells of the articuli small, and of the interior, long and in uniform transverse zones; with polymorphic articuli, genicula corticated, and conceptacles scattered over the articuli; *Cheilosporum,* with the base of the frond terete and flat towards the upper parts, the cortical cells of the articuli elliptic-roundish, and of the interior, long and in uniform transverse zones, articuli sagittate or obcordate, genicula noncorticated, and the conceptacles on the upper margins of the lobes of the articuli; *Arthrocardia,* with fronds subterete near the base and compressed to flat towards the top, the cells of the cortex of the articuli elliptic roundish and of the interior long and in uniform transverse zones, pinnate-branching, the conceptacles terminal on the apices of the articuli, and with noncorticated genicula; *Jania,* with dichotomous branching, the cells of the cortex of the articuli oblong and of the interior filiform and subcontinuous, articuli cylindrical, subclavate or subhastate, genicula noncorticated, and conceptacles terminal and provided with horns; *Corallina,* with branching pinnate, the cells of the cortex of the articuli subspherical and of the interior filiform and elliptical and in uniform transverse zones, articuli compressed or complanate, genicula noncorticated, and terminal conceptacles with or without horns. Areschoug, in addition to elevating *Arthrocardia* and *Cheilosporum* to

generic rank, restored to independent generic rank the genus *Jania* of Lamouroux and referred back all the pinnate species of *Jania* Decaisne to species of *Corallina*. In 1867 J. E. Gray(9) proposed an additional monotypic genus, *Lithothrix* (*L. aspergillum*), recognizable by pustuliform conceptacles scattered on the articuli, pinnate- or verticillate-branching, and articuli short, compressed on the upper parts of the main branches and cylindrical on the branchlets. In 1897 Schmitz and Hauptfleisch(28, pp. 542, 543) adopted only 3 genera, *Amphiroa*, *Cheilosporum*, and *Corallina*, reducing *Arthrocardia* to a synonym under *Cheilosporum* and *Jania* to a synonym under *Corallina*. These authors segregated the three genera by the positions of the conceptacles: in *Amphiroa* conceptacles scattered over the flat surfaces of the joints; in *Cheilosporum* conceptacles terminal, immersed in the apices of the hornlike projections of the joints; in *Corallina* conceptacles likewise terminal, but immersed in the apices of the branches. Incidentally, Schmitz and Hauptfleisch were the first to call attention to the fact that the conceptacles in *Arthrocardia* are strictly terminal, a viewpoint that will be considered in detail later when we deal with the genus *Arthrocardia* and with the genus *Cheilosporum* the conceptacles of which they interpreted as terminal. In 1904 Weber van-Bosse(32) recognized eight genera, distinguishable primarily not only by the position of the conceptacles but also by the structure of the genicula and of the intergenicula. The generic distinctions of this author are summarized in her "Synoptical Key" which runs as follows:–

I. Fronds branched, articulated, calcified joints separated by horny pliable nodes. Joints consisting of a more or less developed cortical layer. Conceptacula either occurring as wart-like or conical processes on the joint or immersed in the tissue of the joint.

a. Joints cylindrical or broadened; in the central strand, rows of short cells are intercalated between rows of the cells all standing vertically one above the other. Nodes consist of 2 or more, rarely one, rows of cells that alternate in the same way as, and have the same size or almost the same size as, the cells of the joint. Conceptacula on the joint. *Amphiroa* Lamx.

b. Joints cylindrical; in the central strand the cells have throughout the whole joint almost the same dimension and stand vertically one above the other. Nodes consist of many rows of cells which are much smaller and have thicker walls than the cells of the joint. Conceptacula on the joint....*Metagoniolithon* g. n.

c. Joints flat short elliptical in outline, with a central strand of non-calcified, intricated filaments, with cells not standing vertically one above the other, and with a considerable layer of calcified cortical cells. Cells of the cortical layer large, near central strand full of big grains of starch, growing smaller towards the periphery, covered by a thick cuticle. Nodes consist of small thick-walled cells. Conceptacula unknown. *Litharthron* g. n.

d. In the central strand all the cells have almost the same dimension throughout the whole joint. Nodes consist of one row of long cells.

1. Joints cylindrical or broadened wing-like; conceptacles form conical protuberances on the joint........ *Arthrocardia* Aresch.
2. Joints cylindrical or broadened wing-like; conceptacles on the upper margin of the broadened wing, immersed in the tissue of the joint .... *Cheilosporum* Aresch.
3. Joints cylindrical or flattened; conceptacles at the growing top of the branches, immersed in the tissue of the joint. *Corallina* Lamx. incl. *Jania* Lamx.

II. Fronds branched, articulated, cylindrical, calcified joints separated by calcified constrictions of the frond. The joints consist of central strand of long, undivided non-calcified filaments standing in vertical rows with the calcified cells of the constrictions, and of a cortical layer of calcified horizontally elongated cells. Conceptacula on the joints.. *Lithothrix* Gray.

Yendo (38) in 1905 recognized only 7 genera by reducing *Arthrocardia* to a section of the genus *Amphiroa*. According to this author, *Amphiroa* has the propagating cells generated in the cortex, the conceptacles on the margins or on the flat surfaces of the articuli, the genicula unizonal or multizonal, and the intergenicular medulla with several zones of "articoli" interposed with zones of "otricoli" or with zones of "articoli" only; *Metagoniolithon* has the propagating cells generated in the medulla, genicula multizonal, and cylindrical articuli and verticillate ramuli; *Lithothrix* has the propagating cells generated in the medulla, the genicula not especially differentiated, the main branching dichotomous, with compressed articuli, and ramuli pinnate, with cylindrical articuli; *Cheilosporum* has the propagating cells generated in the medulla, genicula unizonal, and conceptacles sessile and immersed in the articuli or pinnulets; *Corallina* has the propagating cells generated in the medulla, unizonal genicula, stalked conceptacles, and pinnate branching; *Jania* has the propagating cells generated in the medulla, unizonal genicula, stalked conceptacles, and dichotomous branching; and *Litharthron* has

the propagating cells generated in the medulla, the genicula multizonal, flat articuli, and branching di- or trichotomous.

In the final analysis it has been found that (*a*) in foregoing attempts to distinguish the different genera of the articulated corallines there is no definite uniformity in the characters used, which makes their application most uncertain; (*b*) in all these attempts no consistent effort has been made to determine the type species on which the different genera are founded and to associate with the generic names only species closely related to these types. In the following, an effort will be made to determine the proper type species of each genus and to more clearly determine proper generic limits and specific relationships in accordance with consistency as to type species.

Of the 8 genera thus far proposed (*Amphiroa, Arthrocardia, Cheilosporum, Corallina, Jania, Litharthron, Lithothrix,* and *Metagoniolithon*), the genus *Litharthron* cannot, in the sense of our interpretation, be related to the other articulated corallines. Specimens of *Litharthron australis* from Anna Weber van-Bosse as well as the Harvey specimens (Herbarium of the British Museum and Kew Herbarium) referred to *Amphiroa australis* Sond., on being carefully studied, fully confirmed this point of view. In addition, in 1931, Yamada,(33) after a thorough study of the type, convinced himself that the chosen type of *Litharthron, Amphiroa australis* Sond., is a species of *Rhodopeltis.* The genus *Litharthron* will therefore not be included in the following consideration. During the study of a large number of species of the articulated corallines collected from the west coast of North America and from various parts of the globe, made available through the courtesy of the different European herbaria, there have been found a number of species that cannot be referred to any proposed genera, so that it will be necessary not only to revise the genera already established but also to describe four new genera as well as two new distinguished subgenera to which these species may be referred.

Key to the genera of the articulated corallines.

Plants with terminal conceptacles........ 1.
Plants without terminal conceptacles........ 7.
1. Conceptacles all terminal .... 3.
1. Conceptacles both terminal and lateral........ 2.
2. Intergenicular medullary filaments straight........ 1. *Joculator* Manza.
2. Intergenicular medullary filaments flexuous and interlacing. 2. *Calliarthron* Manza.

3. Branching dichotomous or dichotomous-cymoid........ 3. *Jania* Lamx.
3. Branching wholly or partially pinnate, or pinnate-cymoid........... 4.
4. Branching wholly or partially pinnate. 4. *Corallina* L. (emend. Lamx.) .... 5.
4. Branching pinnate-cymoid (pinnate on vegetative parts and cymoid on fruiting parts)........ 6.
5. Conceptacles nonantenniferous. 4*a*. *Corallina* (*Eucorallina*) subgen. nov.
5. Conceptacles antenniferous. 4*b*. *Corallina* (*Cornicularia*) Manza.
6. Conceptacles upright (pores apical). 5. *Arthrocardia* Decne. (emend. Aresch.).
6. Conceptacles oblique (pores slightly lateral). 6. *Duthiea* Manza.
7. Conceptacles restricted on upper margins of upper lobes of intergenicula.......... 7. *Cheilosporum* Aresch.
7. Conceptacles scattered over surfaces of intergenicula.... 8.
8. Genicula unizonal.......... 9.
8. Genicula multizonal.......... 13.
9. Intergenicular medulla unizonal.... 8. *Lithothrix* Gray.
9. Intergenicular medulla multizonal.......... 10.
10. Intergenicular medullary filaments straight...... 11.
10. Intergenicular medullary filaments flexuous and interlacing .... 2. *Calliarthron* Manza.
11. Intergenicular medullary cells in transverse zones of equal length.......... 12.
11. Intergenicular medullary cells in transverse zones of long and short cells. 9. *Amphiroa* Lamx. (emend. Weber van-Bosse).
12. Intergenicula compressed.... 10. *Bossea* Manza.
12. Intergenicula cylindrical. 11. *Pachyarthron* Manza.
13. Intergenicular medullary cells in transverse zones of equal length. 12. *Metagoniolithon* Weber van-Bosse.
13. Intergenicular medullary cells in transverse zones of long and short cells. 9. *Amphiroa* Lamx. (emend. Weber van-Bosse).

1. Genus JOCULATOR Manza

Joculator MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 47.

Fronds fragile; branching pinnate, mostly pinnate-decompound; segments near base cylindrical or compressed, on upper parts compressed; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles terminal in apices of ramules, lateral on flat surfaces of intergenicula.

Type species: *Joculator pinnatifolius* Manza.

Specimens of the species of this genus have been collected thus far only from the coast of Central California by F. M. Reed, and from Japanese shores (Boshu, Kazusa, Misaki, and Shimoda Provinces) by Yendo. (36, p. 22; 38, p. 26) Species of this genus bear characters of *Corallina* and *Bossea*, having terminal conceptacles borne in the same fashion as those of *Corallina*, and lateral conceptacles borne in similar fashion as those of *Bossea*. In addition, the microscopic structure of the genicula and of the intergenicula of these genera, *Bossea*, *Corallina*, and *Joculator*, are similar: unizonal genicula; intergenicular medullary filaments straight with cells in transverse zones of equal length. Species of these three genera merely differ in the positions of the conceptacles: in *Corallina* the conceptacles are terminal and restricted on the apices of the ramules; in *Bossea* they are limited to the flat surfaces of the intergenicula; and in *Joculator* they are terminal on the apices of the ramules and likewise lateral on the flat surfaces of the intergenicula. *Joculator pinnatifolius* is a very slender species. It has cylindrical or slightly compressed segments near the base and has comparatively thick, flattened, cuneate segments on the branches. The primary divisions of the fronds (or branches) consist of simple ramules below, and long branches above, and these are in turn once or twice pinnately divided, with the divisions likewise made up of simple ramules below and long branchlets above. The ultimate divisions of the branches in this species are always made up of simple ramules. In this species practically all segments except those nearest the base bear opposite members, either simple, short ramules or long, compound branches. The terminal conceptacles are borne on the apices of simple ramules like those of *Corallina officinalis* L., and the lateral conceptacles are borne on the flat surfaces of the ramules, like those of *Bossea plumosa*.

Key to the species of Joculator.

a^1. Fronds 4 to 7 cm long.. 1. *J. pinnatifolius* Manza.
a^2. Fronds 12 cm long.. 2. *J. maximus* (Yendo) Manza.

JOCULATOR PINNATIFOLIUS Manza. Plate 1, figs. 1 and 2.

Joculator pinnatifolius MANZA, Proc. Nat. Acad. Sci. U. S. A. **23** (1937) 47.

Fronds erect, 4 to 7 cm long; branching plumosely bi- or tripinnate and opposite; primary branches consisting of ramules and

long branches once or twice divided, ultimate branches always composed of ramules; intergenicula near base cylindrical or slightly compressed, 1 mm long and 1 mm in diameter, on upper parts on primary branches compressed-cuneate, 1 mm long and 1 to 2 mm broad, on ramules awl-shaped or spathulate, 1 to 3 mm long and 1 mm broad; conceptacles terminal on apices of unsegmented ramules, antenniferous or nonantenniferous, and 2 each on flat surfaces of intergenicula, borne singly near upper lobes. Cystocarpic and antheridial plants unknown.

Type specimen.—Tetrasporic, *Herb. Univ. Calif. No. 545769.* Orange county, coast of Central California; west coast of North America.

Only a single additional species has been described thus far that may be properly referred to this genus.

JOCULATOR MAXIMUS (Yendo) Manza.

Joculator maximus (Yendo) MANZA, Proc. Nat. Acad. Sci. U. S. A. (11) 23 (1937) 567.

Cheilosporum maximum YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo 16 (1902) 22, pl. 2, figs. 18, 19; pl. 6, fig. 9; 20 (1905) 26.

Fronds 12 cm long; branching plumosely bi- or tripinate and opposite, divisions mostly composed of simple ramules on lower parts and of long branches on upper parts, entirely of simple ramules on branchlets; intergenicula near base cylindrical, 1 to 2 mm long and 1 to 1.5 mm broad, intergenicula of upper parts on branches compressed-cuneate, 1 to 2 mm long and 2 to 3 mm broad, intergenicula of ramules spathulate, 2 to 4 mm long and 1 to 2 mm broad; tetrasporic conceptacles both terminal on apices of ramules with pores apical, and lateral on flat surfaces of intergenicula, 2 on each surface borne singly near upper lobes, with pores central.

Type: *Cheilosporum maximum* Yendo. Type specimen in Herb. Imperial Univ. Tokyo.

2. Genus CALLIARTHRON Manza

Calliarthron MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 46.

Fronds extremely fragile; branching dichotomous, pinnate, or dichotomous-pinnate; segments cylindrical or compressed; genicula unizonal; intergenicular medullary filaments flexuous and interlacing; conceptacles semiglobular or conical, borne along margins and flat surfaces of intergenicula, or on apices of ramules, and along margins and flat surfaces of intergenicula.

Type species: *Calliarthron cheilosporioides* Manza.

Species of this genus seem to occur only on the temperate shores. Thus far 10 species are known in this genus; Harvey (specimen in Herb. Kew) collected specimens in Esquimault, British Columbia, and referred them to *Amphiroa rudis*. In 1842 Decaisne (6, p. 112) described *Amphiroa* (*Arthrocardia*) *vertebralis*, collected from Monterey, California. Yendo (36, pp. 16, 19, 21) reported 3 specimens collected from Japan (Kazusa and Hakkodate Provinces) as species of *Cheilosporum*. From the west coast of North America Prof. W. A. Setchell and myself collected 5 new species published in a separate paper.

In the majority of cases species of *Calliarthron* may be distinguished very readily from species of the other genera of the articulated corallines by the position of the conceptacles along the lateral margins of the intergenicula in addition to those on the flat surfaces. Thus far the conceptacles borne along the lateral margins of the compressed intergenicula are found only in most species of this genus. In some species (described in a separate paper), however, the conceptacles are restricted to the flat surfaces of the intergenicula in a fashion similar to those of species of *Bossea*. In this particular case the species of *Calliarthron* differ from species of *Bossea* merely by the structure of the intergenicular medulla. (22, p. 46) In *Calliarthron* the intergenicular medullary filaments are flexuous and interlacing, while in *Bossea* they are straight.

Key to the species of Calliarthron.

*a*¹. Conceptacles both terminal and lateral.
1. *C. modestum* (Yendo) Manza.

*a*². Conceptacles all lateral.
- *b*¹. Conceptacles restricted on convex surfaces of intergenicula.
  2. *C. Schmittii* Manza.
- *b*². Conceptacles scattered over surfaces of intergenicula.
  - *c*¹. Conceptacles borne on flat surface, along lateral margins, and on upper margins of upper lobes of intergenicula.
    3. *C. cheilosporioides* Manza.
  - *c*². Conceptacles borne on flat surface and lateral margins of intergenicula.
    - *d*¹. Branching dichotomous-pinnate.................. 4. *C. Setchelliae* Manza.
    - *d*². Branching pinnate, rarely dichotomous-pinnate.
      - *e*¹. Branching pinnate and subalternate.
        5. *C. yessoense* (Yendo) Manza.
      - *e*². Branching pinnate and opposite, rarely subalternate.
        - *f*¹. Branching interrupted-pinnate and opposite.
          6. *C. regenerans* Manza.

f^2. Branching not interrupted-pinnate.
g^1. Fronds plumosely or densely branched.
7. *C. pinnulatum* Manza.
g^2. Fronds sparsely branched.
8. *C. latissimum* (Yendo) Manza.

CALLIARTHRON CHEILOSPORIOIDES Manza. Plate 2, figs. 1 to 3.

Calliarthron cheilosporioides MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 46.

Fronds erect, 10 to 29 cm long; branching loosely pinnate and opposite or subalternate; intergenicula near base cylindrical, 1 to 6 mm long, 1 to 2 mm in diameter, on upper parts compressed-cuneate or obcordate, with rounded lobes 1 to 2 mm long and 2 to 4 mm broad; conceptacles on upper lobes and lateral margins and flat surfaces of intergenicula appearing first along margin 1 to 3, later crowded on flat surfaces, conical with blunt apices in tetrasporic plants, conical with pointed apices in antheridial plants. Cystocarpic plants unknown.

Calliarthron cheilosporioides, the type of the genus, is the largest species known at present, the fronds attaining a height of about 30 cm. It has long-cylindrical, thick, basal segments, and segments on the upper parts uniformly compressed-cuneate or obcordate, with rounded lobes. This species differs from all species of *Calliarthron* in having conceptacles on the upper lobes of the intergenicula in addition to those on the lateral margins and flat surfaces. These conceptacles on the upper lobes of the intergenicula in this species are borne in almost the same fashion as those in species of *Cheilosporum*, so that the designation *Calliarthron cheilosporioides* is chosen to signify the *Cheilosporum*-like nature of the species. Of this species only tetrasporic and antheridial plants have been collected thus far. The antheridial plants are very much smaller than the tetrasporic plants, the former being about 15 cm high and the latter about 30 cm high. The antheridial plants bear conical conceptacles with extremely pointed apices, giving the flat surfaces of the intergenicula a spiny appearance and the lateral margins a serrate outline, while the tetrasporic plants bear conical conceptacles with blunt apices, giving the surfaces of the intergenicula a warty appearance.

Type specimen.—Tetrasporic, *Herb. Univ. Calif. No. 545724;* Pacific Grove, coast of central California; antheridial, *Herb. Univ. Calif. No. 545721.* Pebble Beach, Carmel Bay, coast of central California, west coast of North America. In Herb. Univ. Calif.

There are 9 additional species thus far described which may be properly referred to this genus:

CALLIARTHRON RUDIS (Harvey) Manza comb. nov.

Amphiroa rudis HARVEY (in Herb. Kew).

CALLIARTHRON VERTEBRALIS (Decaisne) Manza comb. nov.

Amphiroa (Arthrocardia) vertebralis DECAISNE, Mem. sur les Corallines (1842) 112.

In *Calliarthron rudis* and *Calliarthron vertebralis* we have only fragments of probably the type specimens for study, so that specific descriptions are impossible. Study of the fragments shows that the genicula are unizonal, the intergenicular medullary filaments are flexuous and interlacing, and the conceptacles are borne along the margins and flat surfaces of the intergenicula, which are characters of species of *Calliarthron* and not of species of *Amphiroa* under which they were referred previously. As available specimens of those species are merely fragments of the segments, it seems best at present to recognize their present designations and to merely list them under *Calliarthron.*

CALLIARTHRON MODESTUM (Yendo) Manza.

Calliarthron modestum (Yendo) MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 564, 565.

Cheilosporum anceps var. *modesta* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo 16 (1902) 19, pl. 2, fig. 9; pl. 6, fig. 3; ibid. 20 (1905) 20.

Fronds 5 cm long, branching pinnate and opposite to subalternate; intergenicula near base cylindrical or subcompressed, 1 mm long and 1 mm broad, intergenicula of upper parts compressed, mostly obcordate with lobes acute, 2 mm long and 2 to 3 mm broad; tetrasporic conceptacles mostly along lateral margins and flat surfaces of intergenicula, but occurring sometimes on apices of simple ramules.

Type: *Cheilosporum anceps* var. *modesta* Yendo, in Herb. Imp. Univ. Tokyo.

Type locality.—"Hakkodate, Japan."

The type of this species is not available for study, but we have an excellent specimen of the variety whose designation is in the handwriting of Yendo, which shows characters of species of *Calliarthron,* and on which specific diagnosis is based.

CALLIARTHRON YESSOENSE (Yendo) Manza.

Calliarthron yessoense (Yendo) MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 566, 567.

Cheilosporum yessoense YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo 16 (1902) 19, pl. 2, figs. 12, 13; pl. 6, fig. 5; ibid. 20 (1905) 20.

Fronds 7 cm long; branching pinnate and subalternate; intergenicula near base cylindrical, 1 to 2 mm long and 1 mm broad, intergenicula of upper parts compressed, obcordate, with lobes rounded, 2 mm long and 2 to 6 mm broad; tetrasporic conceptacles along lateral margins and on flat surfaces of intergenicula.

Type: *Cheilosporum yessoense* Yendo. Topotype specimen: tetrasporic, *Herb. Univ. Calif. No. 90783.*

Type locality.—"Hakkodate, Japan."

The type of this species is not available for examination, but we have excellent material of topotype specimens seemingly collected and determined by Yendo himself, on which the specific diagnosis is based.

CALLIARTHRON LATISSIMUM (Yendo) Manza.

Calliarthron latissimum (Yendo) MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 564.

Cheilosporum latissimum YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo 16 (1902) 21, pl. 2, figs. 16, 17; pl. 6, fig. 7; ibid. 20 (1905) 20.

Fronds 7 cm long; branching pinnate and opposite to subalternate; intergenicula near base cylindrical or slightly compressed, 1 to 2 mm long and 2 mm broad, intergenicula on upper parts compressed-obcordate with lobes rounded, 2 to 3 mm long and 3 to 5 mm broad; tetrasporic conceptacles both along margins and on flat surfaces of intergenicula.

Type: *Cheilosporum latissimum* Yendo. Topotype specimen: tetrasporic, *Herb. Univ. Calif. No. 418147.*

Type locality.—Kazusa, Japan.

Since the exact type of this species is not available for study, a topotype seemingly collected and determined by Yendo himself was examined. It bears all essential characters of species of *Calliarthron* according to the present treatment of the genus.

CALLIARTHRON PINNULATUM Manza. Plate 3.

Calliarthron pinnulatum MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 565.

Fronds 7 to 11 cm long; branching plumously bi- or tripinnate and opposite (rarely dichotomous-pinnate), primary divisions composed of simple ramules and long branches, once or twice pinnately divided and entirely composed of simple ramules on branchlets; intergenicula near base thick, cylindrical or subcompressed, 1 to 3 mm long and 2 mm broad, on upper parts on branches compressed-cuneate, 2 to 3 mm long and 2 to 3 mm broad, on branchlets spathulate, 2 to 4 mm long and 1 to 2 mm broad; tetrasporic conceptacles on flat surfaces of intergenicula,

mostly 2 on each surface, borne singly near upper margins of upper lobes, single and central on flat surfaces of ramules, with pores central and tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 545963;* Moss Beach, San Mateo County, coast of central California, west coast of North America.

CALLIARTHRON REGENERANS Manza. Plate 4, figs. 1 to 4.

Calliarthron regenerans MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 565.

Fronds 7 to 15 cm long; branching interrupted-pinnate and opposite or dichotomous-interrupted-pinnate and opposite; intergenicula near base cylindrical or slightly compressed, 1 to 4 mm long and 1 to 2 mm broad, on upper parts on primary branches compressed-obcordate, with rounded lobes, on branchlets cylindrical, 2 to 3 mm long and 1 to 4 mm broad; conceptacles along lateral margins and flat surfaces of intergenicula, 2 to 3 along margins and crowded on flat surfaces, semiglobular in tetrasporic plants, conical with blunt apices in cystocarpic plants, and conical with pointed apices in antheridial plants.

Types: tetrasporic, in *Herb. Univ. Calif. No. 545737;* cystocarpic, *Herb. Univ. Calif. No. 545738;* antheridial, *Herb. Univ. Calif. No. 545775;* Moss Beach, San Mateo County, coast of central California, west coast of .North America. Collected by the author.

CALLIARTHRON SCHMITTII Manza. Plate 5.

Calliarthron Schmittii MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 566.

Fronds compressed, with midrib prominent and dorsoventral; branching dichotomous or dichotomous-lateral; intergenicula near base cylindrical, 1 to 4 mm long and 1 mm in diameter, on upper parts compressed, convex, with prominent midrib, suborbicular or subobcordate, with margins entire or irregularly lobed, 5 to 10 mm long and 5 to 15 mm broad; tetrasporic conceptacles semiglobular on convex surfaces of intergenicula, borne along midrib; pores central and tetraspores basal.

Type specimen: tetrasporic, *Herb. Univ. Calif. No. 545744;* dredged from 21 to 24 fathoms, Point Loma, coast of southern California, west coast of North America. Collected by W. Schmitt, *D–4303,* U. S. F. C. Str. Albatross, 1904.

We have only fragmentary specimens of the species. According to all indications, the fronds are creeping. This is the

only species of the genus thus far known with convex intergenicula, dorsoventral, and the conceptacles restricted on convex (upper) surfaces.

CALLIARTHRON SETCHELLIAE Manza. Plate 6, figs. 1 to 4.

Calliarthron Setchelliae MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 566.

Fronds 9 to 16 cm long; branching dichotomous-pinnate and opposite; intergenicula near base slightly compressed, 1 to 3 mm long and 2 to 3 mm broad, on upper parts compressed-cuneate or obcordate, 2 to 3 mm long and 3 to 5 mm broad, with lobes obtuse; tetrasporic conceptacles semiglobular, cystocarpic conceptacles conical, with blunt apices, antheridial conceptacles conical with pointed apices, borne along margins and flat surfaces of intergenicula, 2 to 4 along margins and crowded on flat surfaces.

Type: tetrasporic, *Herb. Univ. Calif. No. 545733;* cystocarpic, *Herb. Univ. Calif. No. 548906;* antheridial, *Herb. Univ. Calif. No. 548904;* Moss Beach, San Mateo County, coast of central California, west coast of North America. Collected by the author.

3. Genus JANIA Lamouroux

Jania LAMOUROUX, Nouv. Bull. des Sci. par la Soc. Philomat. 3 (1812) 186; Hist. Polyp. Flex. (1816) 266–274.

Fronds fragile; branching strictly or largely dichotomous or dichotomous-cymoid; genicula unizonal; intergenicular medullary filaments straight, cells in transverse zones of equal length; conceptacles terminal in apices of ultimate branchlets or in cymoid clusters with ultimate conceptacles antenniferous or nonantenniferous.

Type species: *Corallina rubens* Linnæus.

There are a considerable number of described species properly referrable to *Jania* with certainty, but as yet without proper designation. According to all indications, species of *Jania,* with the present limits of the genus, are tropical and subtropical.

In 1812 Lamouroux proposed the genus *Jania,* and listed under it 6 species, *Jania spermophorus* Lamx., *J. rubens* (Linn.) Lamx., *J. corniculata* Lamx., *J. fragilissima* (Linn.) Lamx., *J. cristata* Lamx., and *J. granifera* Lamx. In 1816 he included under his revised *Jania, Jania rubens, J. corniculata,* and 8 other species that seemingly are still referrable to *Jania.* In the same account he reduced *Jania cristata* and *Jania spermophorus* to varieties of *Jania rubens,* referred *Jania fragilissima* to *Amphiroa fragi-*

lissima, and *Jania granifera* to *Corallina granifera.* In 1842 Decaisne (6, pp. 110, 111) listed *Jania rubens* and *J. corniculata* among his 4 dichotomous species with terminal and antenniferous conceptacles, and 6 among his pinnate species with terminal and antenniferous conceptacles. In 1852 Areschoug (3, pp. 553–560) described 6 species all of which are species of *Jania* according to the present restrictions of the genus, including *Jania rubens* and *J. corniculata.* In 1897 Schmitz and Hauptfleisch (28, p. 543) included this genus under *Corallina,* and listed *Corallina rubens* Linn. along with *Corallina officinalis* L. and *C. mediterranea* Aresch. as typical species of *Corallina,* having the conceptacles terminal and immersed in the apices of the segments. In 1904 Weber van-Bosse (32, pp. 86, 107, 108) listed 3 species referable to *Jania* as restricted, including *Jania rubens.* In 1905 Yendo (38, pp. 2, 37–41) listed 22 species of *Jania,* including *Jania rubens,* and reducing *J. corniculata* to a variety of *Jania concatenata.* Of these species *Jania rubens* (Linn.) Lamx. is the species first mentioned by Lamouroux and seemingly regarded as typical of *Jania,* so that it seems but proper to designate it as the type of the genus.

In 1816 Lamouroux limited the genus to dichotomous species with slender articuli and practically, as his figures show, but not technically, for he did not say so, to species with terminal conceptacles, his figures (17, pl. 9, figs. 6, 7) of the generic type, *Jania rubens* (Linn.) Lamx., clearly emphasizing the latter viewpoint. Decaisne emphasizes more particularly the presence of the so-called horns in his generic concept, thus including in his genus, *Jania,* antenniferous species not only with dichotomous branching and with terminal conceptacles but also with pinnate branching and terminal conceptacles. Areschoug and Yendo restricted it to species primarily with dichotomous branching. Although she does not draw a definite line of demarcation between *Jania* and *Corallina* in her Synoptical Key to the genera of the Corallineae verae, Weber van-Bosse in her list of species (32, p. 107) recognizes its generic independence. In her Synoptical Key to the genera of Corallineae verae she points out definitely that the genus includes species with unizonal genicula, with the intergenicular medullary filaments straight, with cells in transverse zones of equal length, and seemingly with dichotomous branching, since she includes under *Jania* species only with branching dichotomous, such as *Jania adhaerans* Lamx.,

Jania rubens (L.) Lamx., and *Jania tenella* Kuetz., which can properly be referred to *Jania* as restricted.

From the study of the Linnæan type, of which we have excellent photographs, and species showing all essential characters of the type, as well as other species which are properly referrable to *Jania,* it has been found that the conceptacles not only are terminal and the branching dichotomous, but the genicula are unizonal, and the intergenicular medullary filaments are straight with cells in transverse zones of equal length. Consequently it seems proper not only to delimit *Jania* to species showing these essential characters but also to recognize its generic independence, since a definite line of demarcation can be drawn between it and any other genus of the articulated corallines.

Key to the species of Jania.

a^1. Fronds slender, 3 cm long, branching wholly dichotomous.
1. *J. rubens* (Linn.) Lamx.

a^2. Fronds large, 5 to 8 cm long; branching on lower parts dichotomous, on upper parts digitate.. 2. *J. digitata* Manza.

JANIA RUBENS (Linn.) Lamouroux.

Jania rubens (Linn.) LAMOUROUX, Nouv. Bull. Sci. Soc. Philomat. 3 (1812) 186.

Corallina rubens LINNÆUS, Syst. Nat. ed. 12 1 (1767) 1305.

Fronds slender, 3 cm long, in dense tufts; branching dichotomous-cymoid; intergenicula cylindrical, ultimate apices acute, approximately 0.5 to 0.75 mm long and 0.25 mm in diameter; conceptacles terminal, wholly or partially in cymoid clusters, terminal conceptacles mostly antenniferous, pores apical, and tetrasporangia basal.

Type.—Corallina rubens Linnæus.

Type locality.—"O. Europaeo."

Jania rubens (Linn.) Lamx. was first described by Linnæus (21, p. 1305) as *Corallina rubens,* as having dichotomous branching and cylindrical articuli with broader upper ends. According to Lamouroux (17, pp. 271–273) *Jania rubens* has terminal conceptacles borne singly or in "chaplets," with the ultimate conceptacles distinctly provided with one or two appendages; dichotomous branching; and cylindrical or club-shaped articuli. Areschoug (3, p. 557) described it as follows:

Fronde breviori caespitosa, axillis patentibus, ramis subarcuatis, articulis ramiferis subcuneatis, eramiferis cylindraceis, utrisque diametro 4 plo–6 plo longioribus, dichotomiis superioribus ultimisque keramidiferis, keramidiis urnaeformibus poro producto, cornibus subaequi-crassis.

In all these accounts of the species restriction no mention has even been made of the size of the plants. The Linnæan type specimen of *Jania rubens*, according to excellent photographs, is a very slender species. The branching is dichotomous in the vegetative parts with the divisions of long branches, but cymoid on the fruiting parts on account of the conceptacular antennæ of seemingly simple ramules becoming conceptacular in a seemingly unlimited fashion. The intergenicula are generally cylindrical, except those bearing branches in which they are slightly club-shaped. In addition, the apices of the ultimate segments are pointed.

A considerable number of additional species that can properly be referred to *Jania* have been described, but their designations are as yet to be ascertained. In addition we have at least one new South African species properly distinguished and described, namely:

JANIA DIGITATA Manza.

Jania digitata MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 571, 572.

Fronds 5 to 8 cm long; branching dichotomous-digitate-cymoid; intergenicula near base cylindrical, 1 to 2 mm long and 1 mm in diameter, on upper parts on primary branches cylindrical or slightly compressed, club-shaped, and on ultimate branchlets gradually becoming slender, cylindrical, 2 to 3 mm long and 1 to 1.5 mm broad; tetrasporic conceptacles terminal, in cymoid clusters, with ultimate conceptacles provided with 2 lateral proliferations, pores apical, and tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 564574;* Cape Peninsula, South Africa; Coll. Ecol. Surv. *F–123.*

4. Genus CORALLINA Linnæus (emend. Lamouroux)

Corallina LINNÆUS, Syst. Nat. ed. 12 pt. 2 1 (1767) 1304–1306; LAMOUROUX, Nouv. Bull. Sci. Soc. Philomat. 3 (1812) 185, 186, Hist. Polyp. Flex. (1816) 275–292.

Fronds fragile; branching wholly or partially pinnate; genicula unizonal; intergenicular medullary filaments straight with cells in transverse zones of equal length; conceptacles terminal on the apices of the ramules or short branches, with or without "antennæ."

The genus *Corallina* was used as early as 1719 by Tournefort,(31) in 1767 by Linnæus(21) and in 1786 by Ellis,(8) but the designations included not only the articulated corallines in gen-

eral but also many other calcareous algæ, such as species of *Halimeda*, species of *Galaxaura*, and even corals. Lamouroux, in the early part of the 19th century, however, limited the scope of the term *Corallina* to a restricted group of calcareous algæ that includes only, according to our interpretation, the articulated corallines (Corallineae verae Weber van-Bosse), so that the practical establishment of the genus may be rightfully attributed to him.

When *Corallina* was reformed by Lamouroux in 1812 he listed 3 species, *Corallina officinalis* Ell., *C. rosarium* Ell., and *C. loricata* Ell., but in 1816 he described 21 species, including, however, only 2 of his former species, *Corallina officinalis* and *C. loricata*. These 2 species were mentioned again among 9 others in 1842 by Decaisne.(6, pp. 119–122) Harvey in 1847(10, pp. 103, 104) described 5 species including *Corallina officinalis* and *C. loricata*. In 1852, however, Areschoug,(3, pp. 560–576) in describing 15 species, referred *C. loricata* and 8 others to *C. officinalis*, and Ardissone in 1883(2, pp. 462, 463) likewise recognized *C. loricata* with 2 other species as akin to *C. officinalis*. In 1897 Schmitz and Hauptfleisch(28, p. 543) listed under *Corallina*, *Corallina officinalis* Linn., *C. mediterranea* Aresch., and *C. rubens* Linn. Yendo,(38, pp. 1, 2, 27–37) who in 1905 listed 21 species, likewise referred *C. loricata* to *C. officinalis* and reduced several other species to forms of *C. officinalis*. Of these species *Corallina officinalis* Linn. may be adopted as the type. It was the first in the list of Lamouroux under the genus *Corallina*, and has since consistently been recognized as a typical *Corallina* by practically all authors.

The generic diagnosis of *Corallina* has undergone variations since Lamouroux, and different characters have been emphasized. Lamouroux in 1812 and in 1816 restricted the genus to species with pinnate branching. In 1842 Decaisne limited the genus to species with terminal nonantenniferous conceptacles and with pinnate branching, and referred all species with terminal antenniferous conceptacles with branching either pinnate or dichotomous to *Jania*. Harvey in 1847 seems to have followed the generic restriction of Decaisne. In 1852 Areschoug, and Yendo in 1905, referred to the genus all species with terminal conceptacles antenniferous or nonantenniferous, but with pinnate branching. In 1904 Weber van-Bosse(32, p. 86) made no definite statement of her concept of the genus *Corallina*, since she did not separate *Corallina* from *Jania* in her Synoptical Key to the

Genera of Corallineae verae, although she recognized by the binomials in her list (32, p. 107) the generic independence of these two genera. However, she definitely established the fact that in these two genera the conceptacles are terminal, the genicula unizonal, and the intergenicular medullary filaments straight with cells in transverse zones of equal length. In addition, she seemed to recognize that species of *Corallina* have pinnate branching, since she listed under this genus species only with pinnate branching.

The Linnæan type, of which we have excellent photographs, has terminal nonantenniferous conceptacles, and the branching is plumosely pinnate and opposite. It seems best, however, to unite those species having generally pinnate branching and terminal conceptacles in the genus *Corallina,* but since two sets of species are represented, (*a*) those with terminal nonantenniferous, and (*b*) those with terminal antenniferous conceptacles, it likewise seems best to establish two subgenera, *Eucorallina* and *Cornicularia.*

4a. Subgenus EUCORALLINA subgen. nov.

Fronds fragile; branching wholly or partially pinnate; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles nonantenniferous, terminal on apices of ramules or short branches.

Species generis Corallinae conceptaculis nonantenniferis includens.

Species that have been described and are properly referable to *Eucorallina* have been collected thus far from Mediterranean shores, the coast of New Zealand, and the coast of Chile, suggesting that *Eucorallina* is restricted to temperate species.

Type species: *Corallina* (*Eucorallina*) *officinalis* Linnæus.

CORALLINA (EUCORALLINA) OFFICINALIS Linnæus. Plate 7, figs. 1 to 5.

Corallina officinalis ELL. in Linnæus, Syst. Nat. ed. 12 pt. 2 1 (1767) 1304.

Fronds erect, 3 to 4 cm long; branching plumosely bi- or tripinnate and opposite, the primary divisions of long branches once or twice divided, ultimate divisions of simple ramules; intergenicula near base cylindrical, 1 mm long, 1 mm in diameter and compressed on upper parts, on branches subcuneate and 1 mm long and 1 to 1.5 mm broad, on ramules linear or spathulate, 1 to 2 mm long and 0.5 mm broad; conceptacles terminal, nonantenniferous on apices of simple ramules, with pores apical and tetrasporangia basal.

Type: *Corallina officinalis* Linnæus in Herb. British Museum.

Type locality.—"O. Europeo, Mediterraneo."

Many descriptions of the type species have been given, but they have emphasized different characters. Linnæus (21, p. 1304) described it as a plant with pinnate branching and with subconical articuli. According to Lamouroux, (17, p. 283) it has bipinnate branching and cuneiform articuli. Decaisne (5, pl. 17, fig. 1, *c*) figured it as having nonantenniferous terminal conceptacles borne on the apices of the ramules. Harvey (10, p. 104) described it as having pinnate or bipinnate branching, with articuli cylindrical near the base and compressed near the tips. Areschoug (3, p. 562) limited it to plants with branching pinnate, pinnules simple, thick or subclavate; articuli on the primary portions compressed or subcompressed and cylindrical on the pinnules; conceptacles nonantenniferous, oval-subspherical, and provided with long pedicels. *Corallina officinalis* is a small species, about 4 cm high. The segments are slightly compressed except near the base. At times the primary branches near the base are made up of simple ramules, but in such cases they are few. The ramules which are the ultimate divisions of the branches are simple, being made up of basal genicula and unsegmented upper portions upon the apices of which the conceptacles may be borne. In other species of *Corallina* the stalks bearing the conceptacles are made up of a number of genicula and intergenicula.

There appear to be only 4 additional species (3, pp. 562–567) described that can be properly included under *Eucorallina:*

CORALLINA (EUCORALLINA) NANA Zanard.

Corallina (Eucorallina) nana ZANARD in Areschoug, J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 564, 565.

CORALLINA (EUCORALLINA) CHILENSIS Decaisne.

Corallina (Eucorallina) chilensis DECAISNE in Harvey, Ner. Austr. (1847) 103; ARESCHOUG in Agardh, Sp. Alg. pt. 2 2 (1852) 565, 566.

Corallina officinalis var. *chilensis* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 30.

CORALLINA (EUCORALLINA) BERTERI Mont.

Corallina (Eucorallina) Berteri MONT. in Harvey, Ner. Austr. (1847) 103; ARESCHOUG in Agardh, Sp. Alg. pt. 2 2 (1852) 566; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 31.

CORALLINA (EUCORALLINA) ARMATA Hooker f. et Harvey.

Corallina (*Eucorallina*) *armata* HOOKER f. et HARVEY in Harvey, Ner. Austr. (1847) 103; ARESCHOUG in Agardh, Sp. Alg. pt. 2 2 (1852) 566–567; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 31.

The species of *Eucorallina* may be recognized easily by the position and character of the conceptacles and by the mode of branching, such as: conceptacles terminal and nonantenniferous, branching pinnate. These species, *Corallina* (*Eucorallina*) *nana*, *C.* (*E.*) *chilensis*, *C.* (*E.*). *Berteri*, and *C.* (*E.*) *armata*, are listed by Areschoug(3) under his species of *Corallina* with conceptacles terminal and nonantenniferous, and with branching pinnate. The specimens which have been referred to those species, which have been studied also, have the conceptacles terminal and non-antenniferous, and the branching pinnate, so that they may be referred properly to species of *Eucorallina* as restricted. Unfortunately, however, available specimens of these species do not lend themselves to accurate specific description, so that it seems proper, at present, merely to list them under *Eucorallina*.

4b. Subgenus CORNICULARIA Manza

Cornicularia MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 47.

Fronds fragile; branching wholly or partially pinnate; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles terminal on apices of simple ramules or short branches, entirely or mostly antenniferous.

Species generis Corallinae conceptaculis antenniferis includens.

Type species: *Corallina* (*Cornicularia*) *gracilis* Lamouroux.

Species that have been described and that can properly be included under subgenus *Cornicularia*, have been collected, thus far, from subtropical and tropical shores: The coast of Alexandria; Akaroa Island, New Zealand; King George Sound, western Australia; Tasmania; Port Natal, Brazil.

The presence of the so-called horns (conceptacular antennæ) separates the species of *Cornicularia* from those of *Eucorallina*, and the mode of branching (wholly or partially pinnate in *Cornicularia*) separates *Cornicularia* from *Jania* (strictly dichotomous or dichotomous-cymoid in *Jania*). Trevisan, according to Yendo,(39) remarks that "the presence of the horns upon the

conceptacles never offers constant characters," giving the impression that the presence or absence of horns may be variable in the same species. My own observations of a considerable number of species under natural conditions seem to indicate that horns or antennæ are specific characters rather than variables, since in no case were antenniferous conceptacles found in species normally with nonantenniferous conceptacles, although collections were made from a wide range of conditions, while in those normally with antenniferous conceptacles the latter are present in great abundance.

Under *Cornicularia* may be included a number of species previously referred to *Jania* but with pinnate branching,(6, p. 111) such as *Jania elegans* Decne., *J. Cuvieri* (Lamx.) Decne., *J. paniculata* (Lamx.) Decne., *J. crispata* (Lamx.) Decne., *J. rosea* (Lamx.) Decne.,(10, pp. 105, 106) *J. Hombronii* Mont., *J. pistillaris* Mont., *J. gracilis* Mont., and *J. subulata* Sond., as well as a number of species generally referred to *Corallina* whose individuals are largely if not entirely provided with antenniferous conceptacles;(3, pp. 567–574) such as *Corallina squamata* Ell. et Sol., *C. mediterranea* Aresch., *C. elegans* Linorm., *C. subulata* Ell. et Sol., *C. pilifera* Lamx., *C. Cuvieri* Lamx., *C. rosea* Lamx., *C. Hombronii* Mont., and *C. pistillaris* Mont.

Type specimens were not available for examination, but Lamouroux(17, p. 288, pl. 10, fig. 1, *a*, *b*) gives fairly good accounts of the species. According to his description and illustrations, the characters of the plants available for study agree with those indicated for the type. In 1847 Harvey(10, pp. 105, 106) referred it to *Jania gracilis* Mont. In 1852 Areschoug(3, p. 272) referred it, with some doubt, to *Corallina Cuvieri* Lamx., while in 1905 Yendo(38, p. 36) reduced it to a species inquirenda of the genus *Corallina*. *Corallina* (*Cornicularia*) *gracilis* has pinnate branching, so that it cannot consistently be referred to *Jania* if the generic restriction indicated elsewhere in this paper is applicable. *Corallina Cuvieri* Lamouroux,(17, pp. 286, 287, pl. 9, fig. 8, *a*, *b*) the main branching of which is pinnate and opposite, has the ramules divided dichotomously, while *Corallina* (*Cornicularia*) *gracilis* Lamouroux has the main branching pinnate and opposite but with simple ramules, with no dichotomies anywhere, so that it seems proper to recognize their specific entities.

CORALLINA (CORNICULARIA) GRACILIS Lamouroux.

Corallina (*Cornicularia*) *gracilis* LAMOUROUX, Hist. Polyp. Flex. (1816) 288, pl. 10, fig. 1, *a*, *b*.

Fronds erect, dark purple, 6 to 9 cm long; branching plumosely pinnate-tripinnate and opposite, primary divisions of simple ramules and long branches once or twice pinnately divided, ultimate divisions of simple ramules, generally with ramules opposite ramules and branches opposite branches; intergenicula near base cylindrical, 1 mm long, about 0.75 mm in diameter, subcompressed, subcuneate, 1 mm long, about 0.5 mm broad or less on upper parts on primary branches, cylindrical and very slender on ramules; conceptacles terminal on apices of ramules, mostly with two lateral antennæ.

Type: *Corallina gracilis* Lamouroux.

Type locality.—"Australasie."

Although a considerable number of described species of *Cornicularia* have been placed under the genus *Corallina* because of their terminal conceptacles, (3, pp. 567–574; 17, pp. 275–292; 38, pp. 27–41) or else under *Jania* because the conceptacles are terminal and antenniferous, (6, p. 111; 10, pp. 104–106) a large number of these described species must await further study. It seems best, at present, to refer only the following 9 additional species under the subgenus *Cornicularia:*

CORALLINA (CORNICULARIA) MEDITERRANEA Areschoug.

Corallina (*Cornicularia*) *mediterranea* ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 568, 569.

CORALLINA (CORNICULARIA) CUVIERI Lamouroux.

Corallina (*Cornicularia*) *cuvieri* LAMOUROUX, Hist. Polyp. Flex. (1816) 286–287, pl. 9, fig. 8, *a*, *b*.

Jania Cuvieri (Lamx.) DECAISNE, Mem. sur les Corallines (1842) 111; HARVEY, Ner. Austr. (1847) 105.

Corallina cuvieri LAMX., Areschoug in J. A. Agardh, Sp. Alg. pt. 2 2 (1852) 572, 573; KUETZING, Tab. Phyc. 8 (1858) 33, pl. 70, fig. 1, *a–g;* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

CORALLINA (CORNICULARIA) ROSEA Lamarck.

Corallina (*Cornicularia*) *rosea* LAMARCK, Mem. du Mus. (1815) 232.

Jania Cuvieri (Lamx.) DECAISNE, Mem. sur les Morallines (1842) 111; HARVEY, Ner. Austr. (1847) 105, pl. 40, figs. 1–3.

Corallina rosea LAMX., Areschoug in J. A. Agardh, Sp. Alg. pt. 2 2 (1852) 573, 574; KUETZING, Tab. Phyc. 8 (1838) 34, pl. 72, fig. 2, *c–e;* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

CORALLINA (CORNICULARIA) SUBULATA (Sond.) Ellis.

Corallina (*Cornicularia*) *subulata* (Sond.) ELLIS, Cor. (1755) 120, pl. 21, figs. *b*, *c*.

Jania subulata SONDER in Harvey, Ner. Austr. (1847) 106, pl. 40, figs. 1–4.

Corallina subulata ELLIS, Areschoug in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 570, 571; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

CORALLINA (CORNICULARIA) VIRGATA Zanardini.

Corallina (*Cornicularia*) *virgata* ZANARDINI in Kuetzing, Tab. Phyc. 8 (1858) 36, pl. 76, fig. 2 *d–g*; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 30.

CORALLINA (CORNICULARIA) CERATOIDES Kuetzing.

Corallina (*Cornicularia*) *ceratoides* KUETZING, Tab. Phyc. 8 (1858) 36, pl. 75, fig. 2, *c*, *d*.

CORALLINA (CORNICULARIA) TRICHOCARPA Kuetzing.

Corallina (*Cornicularia*) *trichocarpa* KUETZING, Tab. Phyc. 8 (1858) 35, pl. 74, fig. 1, *a*, *b*; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

CORALLINA (CORNICULARIA) PILIFERA Lamouroux.

Corallina (*Cornicularia*) *pilifera* LAMOUROUX, Hist. Polyp. Flex. (1816) 289, 290; KUETZING, Tab. Phyc. 8 (1858) 35, pl. 74, fig. 2, *c*, *d*; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

CORALLINA (CORNICULARIA) DENUDATA Sonder.

Corallina (*Cornicularia*) *denudata* SONDER in Kuetzing, Tab. Phyc. 8 (1858) 34, pl. 73, fig. *a–c*.

Corallina Cuvieri fo. *denudata* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 35.

Of *Corallina* (*Cornicularia*) *mediterranea* we have merely fragments of the segments; of the other species, *Corallina* (*Cornicularia*) *cuvieri*, *C.* (*C.*) *rosea*, *C.* (*C.*) *subulata*, *C.* (*C.*) *virgata*, *C.* (*C.*) *ceratoides*, *C.* (*C.*) *trichocarpa*, *C.* (*C.*) *pilifera*, and *C.* (*C.*) *denudata*, Kuetzing(14) provides fair illustrations of the characters of the fronds. According to the figures of Kuetzing, and judging by the specimens referred to those species, they all belong to *Cornicularia* as the subgenus is restricted; such as branching pinnate, and conceptacles terminal and antenniferous. As we have no suitable specimens of these species for proper description, and as the types were not available for study, they are merely listed under *Cornicularia*.

5. Genus ARTHROCARDIA Decaisne (emend. Areschoug)

Arthrocardia DECAISNE, Class. des Algues (1842) 63, pl. 17, fig. 8; Mem. sur. less Corallines (1842) 112, 113 (*nomen nudum*); ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 547–553.

Fronds fragile; branching pinnate-cymoid; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles terminal and in cymoid clusters, upright or with pores apical.

Type species: *Arthrocardia corymbosa* (Lamk.) Decaisne.

There are, at present, only 8 additional species that can properly be referred to *Arthrocardia,* all of which have been collected from South Africa, suggesting that the species of this genus are not only strictly temperate but exclusively South African.

The genus *Arthrocardia* was first proposed in 1842 by Decaisne, who cited 3 species, *Arthrocardia sagittata* Decne., *Arthrocardia corymbosa* (Lamk.) Decne., and *Arthrocardia prolifera* Decne. In the same year he reduced *Arthrocardia* to a subgenus of *Amphiroa* and listed under it *Amphiroa* (*Arthrocardia*) *corymbosa* (Lamk.) Decne., *Amphiroa* (*Arthrocardia*) *orbigniana* Decne., *Amphiroa* (*Arthrocardia*) *vertebralis* Decne., *Amphiroa* (*Arthrocardia*) *californica* Decne., *Amphiroa* (*Arthrocardia*) *Chiloensis* Decne., and *Amphiroa* (*Arthrocardia*) *prolifera* (Lamx.) Decne., but he referred his *Arthrocardia sagittata* to his *Amphiroa* (*Cheilosporum*) *sagittata,* emphasizing the flattened obcordate intergenicula and conical conceptacles only for his *Arthrocardia.* In 1847 Harvey (10, pp. 99, 100) reduced *Arthrocardia* to a section of *Amphiroa,* referring to it *Amphiroa corymbosa* Decne., *A. Darwinii* Harvey, *A. Mallardiae* Harvey, *A. orbigniana* Decne., and *A. Chiloensis* Decne., and restricting it to species with flattened obcordate intergenicula and conical conceptacles scattered over the flat surfaces of the intergenicula. In 1852 Areschoug elevated *Arthrocardia* to an independent genus, emphasizing the terminal position of the conceptacles, and included under it 5 species, *Arthrocardia frondescens* (P. et R.) Aresch., *Arthrocardia palmata* (Ell. et Sol.) Aresch., *Arthrocardia corymbosa* (Lamk.) Decne., *Arthrocardia Wardii* (Harvey) Aresch., and *Arthrocardia Mallardiae* (Harvey) Aresch. In 1897 Schmitz and Hauptfleisch (28, p. 543) referred *Arthrocardia* as a synonym under *Cheilosporum,* but likewise emphasized the fact that the conceptacles are terminal. In

1904 Weber van-Bosse (32, pp. 86, 105, 106) recognized the generic rank of *Arthrocardia* but cited no species of *Arthrocardia* described by Areschoug, and stated that the conceptacles are scattered over the surfaces of the intergenicula. Consequently the *Arthrocardia* of Weber van-Bosse seems to include largely or entirely species like *Arthrocardia cretacea* (P. et R.) Weber van-Bosse, *Arthrocardia tuberculosa* (P. et R.) Weber van-Bosse, *Arthrocardia variabilis* (Yendo) Weber van-Bosse, *Arthrocardia epiphlegnoides* (Ag.) Weber van-Bosse, *Arthrocardia eberrans* (Yendo) Weber van-Bosse, *Arthrocardia declinata* (Yendo) Weber van-Bosse, *Arthrocardia Darwinii* (Harvey) Weber van-Bosse, *Arthrocardia vertebralis* (Decne.) Weber van-Bosse, and *Arthrocardia breviarticulata* (Aresch.) Weber van-Bosse, not conforming to Areschoug's idea but only to the more general composite idea of Decaisne. (6, pp. 112, 113) In 1905 Yendo (33, pp. 1, 7, 9) reduced *Arthrocardia* again to a section of *Amphiroa*, but his section includes *Amphiroa corymbosa* (Lamk.) Decne., *A. Wardii* Harvey, and *A. Mallardiae* Harvey, all species of *Arthrocardia* in the sense of Areschoug, and described *A. aberrans* Yendo.

The genus *Arthrocardia* as treated by various writers since Decaisne, who named it, includes at least 3 categories of species: (*a*) species with conceptacles strictly terminal, arising from the apical meristem, illustrated by *Arthrocardia corymbosa* (Lamk.) Decne., and its probable synonym *Arthrocardia prolifera* (Lamx.) Decne.; (*b*) species with conceptacles lateral, but adaxially marginal in the hornlike projections of the intergenicula, represented by *Arthrocardia sagittata* (Lamx.) Decne., later chosen as the type of the *Cheilosporum* section of *Amphiroa* by Decaisne in his original list of species of *Arthrocardia* and logically the type of the genus *Cheilosporum* in Areschoug's arrangement; (*c*) species with lateral conceptacles on the flattened surfaces or margins of the intergenicula, such as *Amphiroa* (*Arthrocardia*) *orbigniana* Decne., and *Amphiroa* (*Arthrocardia*) *vertebralis* Decne. Since it seems imperative to delimit the genus to one of these categories; since *Arthrocardia corymbosa* (Lamk.) Decne. was mentioned first, and likewise figured by Decaisne; and since it includes *Arthrocardia prolifera* (Lamx.) Decne. as a probable synonym, *Arthrocardia corymbosa* (Lamk.) Decne. may be designated the type species of the genus, and the genus delimited in accordance with the more general characteristics of the type species. This delimitation

seems to be in accordance with the ideas of Areschoug, who limited the genus to include only species with flattened joints and terminal conceptacles.

Although Decaisne proposed the genus *Arthrocardia* without generic diagnosis, his figure leads to the inference that the genus at least includes species with branching pinnate-cymoid; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of uniform length; conceptacles terminal, practically if not technically exact, since they are situated on the apical meristematic portions of the segments, and the axis upon which they are situated becomes determinate through the cessation of the meristematic activity. When Decaisne reduced *Arthrocardia* to a subgenus of *Amphiroa*, however, (6, pp. 112, 113) he seemed to include under the subgenus all species with segments compressed-obcordate and with conceptacles conical. As a section of *Amphiroa*, Harvey (10, pp. 99, 100) limited it in the same fashion as did Decaisne. Areschoug (3, p. 547) restricted the genus *Arthrocardia* to species with terminal conceptacles, apparently recognizing *Arthrocardia* as the type. Schmitz and Hauptfleisch (28, p. 543) likewise indicated that in *Arthrocardia* the conceptacles are terminal, although they placed *Arthrocardia* as a synonym under *Cheilosporum*. Weber van-Bosse, (32, p. 86) who restored the generic rank of *Arthrocardia*, made the following limitation: plants with conceptacles forming conical protuberances on the faces of the "joints," nodes consisting of one row of cells, all the cells in the central strand having the same dimension throughout. Yendo, (38, p. 1) who reduced *Arthrocardia* to a section of *Amphiroa*, limited it in a fashion similar to the generic limitation proposed by Weber van-Bosse. As may be noticed in the foregoing, writers vary in their restrictions of *Arthrocardia* as a genus, subgenus, or as a section of *Amphiroa*, due possibly to their failure to establish the type and to base their limitation upon the type and related species.

Opinion still varies with regard to the exact position of the conceptacles in *Arthrocardia*. Decaisne in his earlier paper (5) practically but not technically holds the view that the conceptacles are terminal at least in his species, since his figure shows that the conceptacles in *Arthrocardia corymbosa* Decne. and *Arthrocardia prolifera* Decne. are at least on the apices of the intergenicula. In his later paper, where he treats *Arthrocardia* as a subgenus of *Amphiroa*, he seems to include the positions of the conceptacles as lateral, scattered over the surfaces

of the intergenicula, since he cites also *Amphiroa* (*Arthrocardia*) *orbigniana* Decne., *A.* (*Arthrocardia*) *californica* Decne., *A.* (*Arthrocardia*) *vertebralis* Decne., and other species with conceptacles typically lateral and scattered over the surfaces of the intergenicula. Areschoug emphatically states that the conceptacles are terminal on the apices of the intergenicula. Although Schmitz and Hauptfleisch definitely state that the conceptacles in *Arthrocardia* are terminal, they were not consistent in drawing any definite line of demarcation between terminal conceptacles and lateral conceptacles, since they interpret the conceptacles in *Cheilosporum* as being terminal. In *Cheilosporum,* according to the type *Cheilosporum sagittatum* (Lamx.) Areschoug, although the conceptacles are obliquely borne on the inner surfaces of the margins of the upper lobes of the intergenicula, they are lateral, since they spring from the inner margins of the projections of the intergenicula, and arise from the seemingly matured tissue in almost similar fashion as those of *Amphiroa* and *Bossea.* In *Arthrocardia,* as exemplified in the type, *Arthrocardia corymbosa* (Lamk.) Decne., the conceptacles arise directly from the apical meristem, develop vertically, and in their development the entire central cylinder of the apical meristem is used up, terminating any further vertical development of the segments from which they spring. Moreover, in all species of *Arthrocardia* the conceptacles produce generally two lateral branches equatorially and opposite, and each of these, in turn, produces conceptacles on its apices, in a fashion similar to that in certain species of *Jania.* This process is repeated a number of times, resulting in the formation of a system of branching here called, for convenience, cymoid branching. In the type, *Arthrocardia corymbosa* (Lamk.) Decne., and species properly distinguished as species of *Arthrocardia,* not only are the conceptacles terminal and the branching pinnate-cymoid, but the genicula are unizonal and the intergenicular medullary filaments straight with cells in transverse zones of equal length, so that it seems best not only to restrict *Arthrocardia* to species showing those essential characters, but likewise to recognize its independent generic rank.

Key to the species of Arthrocardia.

a^1. Fronds with slender proliferations.
 b^1. Slender proliferations compressed........................ 1. *A. Gardneri* Manza.
 b^2. Slender proliferations more or less cylindrical.
  c^1. Fronds with linear segments on branches.
   2. *Arthrocardia linearis* Manza.

c^2. Fronds without linear segments.................... 3. *A. attenuata* Manza.
a^2. Fronds without slender proliferations.
b^1. Fronds with wholly or partially thick segments.
c^1. Fronds with thick segments throughout.
4. *A. corymbosa* (Lamk.) Decne.
c^2. Fronds with basal segments slender, thick on upper parts.
5. *A. Papenfussii* Manza.
b^2. Fronds with segments thin.
c^1. Fronds with branches of simple ramules.... 6. *A. Setchelliae* Manza.
c^2. Fronds without branches of simple ramules.
d^1. Segments with pronounced midrib........ 7. *A. Stephensonii* Manza.
d^2. Segments without pronounced midrib........ 8. *A. Setchellii* Manza.

ARTHROCARDIA CORYMBOSA (Lamk.) Decaisne.

Corallina corymbosa LAMARCK, Animaux sans Vertebres 2 (1816) 331.
Amphiroa (Arthrocardia) corymbosa (Lamk.) HARVEY, Ner. Austr. (1847) 99; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 7.
Arthrocardia corymbosa DECAISNE, Class. des Algues (1842) 63, pl. 17, fig. 8.

Fronds pinnate-cymoid; intergenicula near base cylindrical, on upper parts compressed-cuneate, 1 to 1.5 mm long and 1 to 2 mm broad and ultimately becoming slender; conceptacles terminal, in cymoid clusters, upright or with pores apical and with tetrasporangia basal.

Type: *Corallina corymbosa* Lamarck.

Type locality.—"ad littora Americae," fide Lamarck; "ad oram Capensem praesertem in sinu Tabulari nec non Algoensi non infrequenter," fide Areschoug.

Arthrocardia corymbosa (Lamk.) Decne. was first described as *Corallina corymbosa* Lamarck, with corymbose branching; basal articuli short, cylindrical, and on the upper parts compressed, cuneiform-sagittate. According to Areschoug, (3, pp. 550, 551) *Arthrocardia corymbosa* has cylindrical segments near the base, compressed on the upper parts, sublinear or ovate-cuneate, with the terminal segments becoming sublinear. The fragments of the type specimen, made available through the courtesy of the authorities of the Musée d'histoire Naturelle, has comparatively thick segments, seemingly cylindrical near the base, compressed-cuneate on the primary branches, ultimately becoming slender. The conceptacles are terminal on the apices of the intergenicula in cymoid clusters, upright or with pores apical and tetrasporangia basal.

Arthrocardia corymbosa is similar in general habit to species of *Duthiea*, differing from the latter only in the position of the

pores of the conceptacles, which are apical in species of *Arthrocardia* and slightly lateral in species of *Duthiea.*

While a fair number of South African species described originally under *Amphiroa* seem referrable to *Arthrocardia* when fertile specimens are examined, there are only 8 other species described at present which may be referable to this genus:

ARTHROCARDIA FLABELLATA (Kuetz.) comb. nov.

Corallina flabellata KUETZING, Tab. Phyc. 8 (1858) 29, pl. 60, fig. 2.

The type is not available for study, but fragments of species showing essential characters were examined. From the study of these fragments, and from available records, the species shows essential characters of *Arthrocardia* and not of species of *Corallina* to which it has been previously referred. On this account, and due to the fact that this species appears different from any species of *Arthrocardia* thus far known, it seems best not only to recognize its specific independence but likewise to recognize it as a species of the *Arthrocardia.*

ARTHROCARDIA ATTENUATA Manza.

Arthrocardia attenuata MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 568.

Fronds 4 to 6 cm long; branching on vegetative parts bi- or tripinnate, branches subalternate, on fruiting parts cymoid; intergenicula near base cylindrical, 1 to 2 mm long and 1 to 2 mm broad, on upper parts on primary branches compressed-cuneate or obcordate, lobes acute, 2 mm long and 2 mm broad, on ultimate branchlets becoming filiform; tetrasporic conceptacles terminal in cymoid clusters, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 548786;* Sea Point, South Africa. Collected by A. V. Duthie.

ARTHROCARDIA GARDNERI Manza.

Arthrocardia Gardneri MANZA, Proc. Nat. Acad. Sci. 23 (1937) 568.

Fronds 4 to 6 cm long; branching on vegetative parts bi- or tripinnate and opposite, with long branches once or twice divided, on fruiting parts cymoid; segments near base thick, gradually becoming slender downward, intergenicula cylindrical, 1 to 2 mm long and 1 to 2 mm broad, on upper parts compressed, intergenicula on primary branches obovate, obcordate, or spathulate, 2 to 4 mm long and 2 to 3 mm broad, on ultimate branchlets becoming gradually slender; tetrasporic conceptacles terminal, in cymoid clusters, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 565485;* Isipingo Beach, Natal, South Africa. Collected by Ecol. Surv. *D. C. 11.*

ARTHROCARDIA LINEARIS Manza.

Arthrocardia linearis MANZA, Proc. Nat. Acad. Sci. 23 (1937) 569.

Fronds 3 to 8 cm long; branching on vegetative parts pinnate and opposite, long branches once or twice divided, ultimate divisions composed of simple, slender ramules, on the fruiting parts cymoid; segments near the base cylindrical, intergenicula 1 to 3 mm long and 1 to 1.5 mm broad, on upper parts compressed, intergenicula of primary branches obcordate, lobes obtuse, 2 to 3 mm long and 2 to 3 mm broad, on branchlets sublinear, 3 to 6 mm long and 1 mm broad, at times becoming filiform; tetrasporic conceptacles terminal, in cymoid clusters, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 564560;* Isipingo Beach, Natal, South Africa. Collected by Ecol. Surv. *D. C. 3.*

ARTHROCARDIA PAPENFUSSII Manza.

Arthrocardia Papenfussii MANZA, Proc. Nat. Acad. Sci. 23 (1937) 569.

Fronds 3 to 5 cm long; branching on vegetative parts pinnate to pinnate-decompound and opposite, long branches once or twice pinnately divided, ultimate divisions consisting of simple ramules, on fruiting parts cymoid; segments near base becoming gradually becoming slender downward, intergenicula cylindrical, 2 to 3 mm long and 1 to 1.5 mm broad, on upper parts on primary branches compressed-cuneate, 2 mm long and 2 to 3 mm broad, on ramuli slightly compressed, subclavate, 3 mm long and 1 to 1.5 mm broad; conceptacles terminal, in cymoid clusters, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 564568;* Collected by G. F. Papenfuss *No. 50;* cystocarpic, *Herb. Univ. Calif. No. 564583;* G. F. Papenfuss *No. 50–A;* Melkbosch, South Africa.

ARTHROCARDIA SETCHELLIAE Manza.

Arthrocardia Setchelliae MANZA, Proc. Nat. Acad. Sci. 23 (1937) 569, 570.

Fronds 3 to 4 cm long; branching on vegetative parts plumosely pinnate to tripinnate and opposite, primary branches long, once or twice divided, ultimate divisions composed of simple ramules, on fruiting parts cymoid; segments near base gradually becoming filiform downward; on upper parts compressed, inter-

genicula on primary branches thick, cuneate-obovate, 2 mm long and 1 mm broad; tetrasporic conceptacles terminal, mostly in cymoid clusters, rarely terminal on simple ramules, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 564557;* Witsands, South Africa. Collected by G. F. Papenfuss *No. 57.*

ARTHROCARDIA SETCHELLII Manza.

Arthrocardia Setchellii MANZA, Proc. Nat. Acad. Sci. 23 (1937) 570.

Fronds 3 to 5 cm long; branching on vegetative parts pinnate and opposite or pinnate-decompound, long branches once or twice divided, short branches composed of simple ramules, on fruiting parts cymoid; segments near base tapering downward, intergenicula slightly compressed or cylindrical, 1 mm long and 2 to 3 mm broad, on upper parts compressed-obcordate, lobes obtuse, rarely acute, 2 mm long and 2 to 3 mm broad; tetrasporic conceptacles terminal, in cymoid clusters, rarely on apices of simple ramules, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 564553;* Port Nolloth, South Africa. Collected by Ecol. Surv. *P. N. C. 5.*

ARTHROCARDIA STEPHENSONII Manza.

Arthrocardia Stephensonii MANZA, Proc. Nat. Acad. Sci. 23 (1937) 570.

Fronds 2 to 4 cm long; branching on vegetative parts pinnate and opposite or pinnate-decompound, on fruiting parts cymoid; segments near base filiform, on upper parts compressed, lobes acute, rarely obtuse, 1 to 2 mm long and 1 to 2 mm broad; tetrasporic conceptacles terminal, in cymoid clusters, pores apical.

Type: tetrasporic, *Herb. Univ. Calif. No. 564581;* St. James, Cape Peninsula, South Africa. Collected by Ecol. Surv. *F–121.*

Genus DUTHIEA Manza

Duthiea MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 48.

Fronds fragile; branching pinnate-cymoid (branching in vegetative stages pinnate, in fruiting stages cymoid); segments near base cylindrical or compressed, on upper parts compressed; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles terminal in cymoid clusters, with pores slightly lateral or slightly below apices of segments.

Type species: *Duthiea Setchellii* Manza.

Thus far only the type species is known in this genus, *Duthiea Setchellii,* specimens of which have thus far been collected only

by Dr. A. V. Duthie, from Blauwklip, South Africa. In general habit species of *Duthiea* and of *Arthrocardia* are very closely similar, both having the branching pinnate in the vegetative portions but cymoid in the fruiting parts, with the conceptacles borne in similar positions in each genus. The two genera differ merely in the positions of the pores of the conceptacles. Relative to the apices of the segments on which they are borne, the pores in *Duthiea* are distinctly below the apices of the conceptacles, while in *Arthrocardia* they are strictly terminal. On account of the positions of the pores, the conceptacles in *Duthiea* could be described as lateral, since they are partially or wholly on the flat surfaces of the intergenicula. In our discussion in connection with the conceptacles, however, attention was called to the fact that the so-called terminal conceptacles originate from the apical meristem, and in their developments the apical meristem is wholly or partially transformed, while the so-called lateral conceptacles of the other genera originate from the seemingly mature tissue of the intergenicula. In *Duthiea* the conceptacles are developed from the apical meristem, and in their development the entire central meristematic cylinder of the apical meristem is involved, so that the conceptacles may properly be called terminal. This peculiar position of the conceptacular pores in *Duthiea* is due merely to the conceptacles themselves developing obliquely or slightly sideways instead of upright or parallel to the axis of the segments upon which they are borne. I have stated that in species of *Corallina* (*Cornicularia*) most of the conceptacles are antenniferous or provided with lateral proliferations of varying number, depending on the species. In *Duthiea* and in *Arthrocardia,* as well as in most species of *Jania,* these conceptacular antennæ, normally two, borne one opposite the other, become conceptacular and become, in turn, antenniferous in the same fashion as in the one from which they spring. The repetition of this process results in the determinate type of branching, which in this account is called cymoid branching to differentiate this sympodial from monopodial indeterminate branching which is normal to all strictly pinnate species.

DUTHIEA SETCHELLII Manza. Plate 8, figs. 1 and 2.

Duthiea Setchellii MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 48.

Fronds erect, 4 to 6 cm long; branching in vegetative parts pinnate or tripinnate and opposite, on fruiting parts cymoid; intergenicula near base cylindrical, 1 to 2 mm long and 1 to 2

mm in diameter, on upper parts compressed-cuneate or obcordate, with lobes obtuse, 2 mm long and 2 to 3 mm broad; conceptacles terminal, in cymoid clusters, oblique or with pores slightly below apices of segments, tetrasporangia borne on base and along wall of conceptacular cavity. Cystocarpic and antheridial plants unknown.

Type: Tetrasporic, Blauwklip, near the mouth of Grote River, South Africa (*Herb. Univ. Calif. No. 545765; Duthie No. 8012 in Herb. Univ. Calif.*).

Duthiea Setchellii is similar to *Arthrocardia corymbosa* in general habit, but differs from the latter in the position of the pores of the conceptacles, this being slightly lateral in *Duthiea Setchellii* and absolutely terminal in *Arthrocardia corymbosa* as well as in all other species of *Arthrocardia.* Moreover, in *Duthiea Setchellii* the tetrasporangia spring not only from the bases of the conceptacles but likewise from along the lateral walls of the conceptacular cavity, while in *Arthrocardia corymbosa* the tetrasporangia are borne strictly on the bases of the conceptacles.

7. Genus CHEILOSPORUM Areschoug

Cheilosporum ARESCHOUG in J. G. Agardh, Sp. Alg. p. 2 2 (1852) 543–547.

Fronds fragile; branching wholly or partially dichotomous; genicula unizonal; intergenicular medullary filaments straight, cells in transverse zones of equal length; conceptacles restricted on upper margins of upper lobes of intergenicula.

Type species: *Cheilosporum sagittatum* (Lamx.) Areschoug.

Species of *Cheilosporum* seem to have a very extensive range of distribution, specimens being collected from temperate and tropical shores, Île-de-France, the coast of Brazil, Cape of Good Hope, Mauritius Islands, and Java.

Cheilosporum was treated first as a subgenus of *Amphiroa* by Decaisne, who listed 4 species, *Amphiroa* (*Cheilosporum*) *sagittata* (Lamx.) Decne., *A.* (*Cheilosporum*) *acutiloba* Decne., *A.* (*Cheilosporum*) *Lamourouxiana* (Leach) Decne., and *A.* (*Cheilosporum*) *fastigiata* Decne. Harvey (10, pp. 101, 102) treated *Cheilosporum* as a section of *Amphiroa* and described under it 7 species, including *Amphiroa sagittata* Decne. Areschoug elevated *Cheilosporum* to an independent genus and described under it 6 species, *Cheilosporum stangeri* (Harvey) Aresch., *Cheilosporum flabellatum* (Harvey) Aresch., *Cheilosporum sagittatum* (Lamx.) Aresch., *Cheilosporum cultratum* (Harvey) Aresch.,

Cheilosporum elegans (Hook. fil. et Harvey) Aresch., and *Cheilosporum jungermannioides* (Rupr.) Aresch., but reduced *Amphiroa* (*Cheilosporum*) *acutiloba* Decne. to a species inquirenda. /8 Schmitz and Hauptfleisch (29, p. 543) recognized the generic rank of *Cheilosporum*, and definitely established *Cheilosporum sagittatum* (Lamx.) Areschoug as the type species. They, however, placed *Arthrocardia* under *Cheilosporum* as a synonym. Weber van-Bosse (32, pp. 86, 106, 107) adopted *Cheilosporum* and listed 2 species, *Cheilosporum spectabile* (Harvey) Weber van-Bosse, and *Cheilosporum jungermannioides* (Rupr.) Areschoug, while Yendo (38, pp. 2, 17–27) adopted the genus with much wider application by proposing sections including species that are not species of *Cheilosporum* as restricted, such as those included under his sections *Alatocladia* and *Serraticardia*. He regarded *Cheilosporum elegans* Areschoug, *Cheilosporum sagittatum* (Lamx.) Aresch., *Cheilosporum jungermannioides* (Rupr.) Aresch., *Cheilosporum spectabile* (Harvey) Weber van-Bosse, and *Cheilosporum cultratum* (Harvey) Aresch. as typical species of *Cheilosporum*, listing them under the section *Eucheilosporum*. Of these species, referred to *Cheilosporum*, *Cheilosporum sagittatum* (Lamx.) Aresch. was the first mentioned by Decaisne when he proposed *Cheilosporum* as a subgenus of *Amphiroa*, and this species was not only definitely designated by Schmitz and Hauptfleisch as the type of the genus, but also cited by Yendo (38, p. 18) as one of the typical species of *Cheilosporum*. It is one of the species seemingly recognized by most authors as a typical *Cheilosporum*, so that it seems best to follow Schmitz and Hauptfleisch in considering *Cheilosporum sagittatum* (Lamx.) Aresch. as the type of the genus.

When Decaisne proposed *Cheilosporum* as a subgenus of *Amphiroa* it was limited to species primarily with conceptacles in the upper margins of the upper lobes of the intergenicula. Harvey, who reduced *Cheilosporum* to a section of *Amphiroa*, restricted it in a fashion similar to the subgeneric limitation of Decaisne. According to Areschoug, *Cheilosporum* includes species primarily with conceptacles in the upper margins of the upper lobes of the intergenicula, and with dichotomous branching. Schmitz and Hauptfleisch likewise restricted the genus to the species with the conceptacles immersed in the upper margins of the upper lobes of the intergenicula, a position of the conceptacles interpreted as terminal. The conceptacles in *Cheilosporum* as restricted are lateral, since they spring from the sides

of the segments and not from the apices of the segments. Weber van-Bosse, who adopted the genus, farther described it as consisting of species not only with conceptacles immersed in the upper margins of the upper lobes of the intergenicula, but also with genicula unizonal; with intergenicular medullary filaments straight and cells in transverse zones of equal length. Yendo extended its limit by referring to it species not only with conceptacles restricted to the upper margins of the upper lobes of the intergenicula, but also species with conceptacles scattered over the flat surfaces of the intergenicula, and with conceptacles both terminal on the apices of the ramules and lateral on the flat surfaces of the intergenicula. This author states, however, that in the true *Cheilosporum* (*Eucheilosporum*) the conceptacles are restricted to the upper margins of the upper lobes of the intergenicula. Species of *Cheilosporum* have been found not only to have conceptacles restricted to the upper margins of the upper lobes of the intergenicula, but also the genicula unizonal. They also have intergenicular medullary filaments straight, with cells in transverse zones of equal length, so that it seems proper not only to delimit *Cheilosporum* to species showing those essential characters but also to recognize its independent generic rank.

Key to the species of Cheilosporum.

a^1. Branching dichotomous.
  b^1. Margins of the intergenicula entire.
    c^1. Conceptacles single on each lobe.
      3. *C. sagittatum* (Lamx.) Aresch.
    c^2. Conceptacles 1 to 3, generally 2, on each lobe.
      4. *C. cultratum* (Harvey) Aresch.
  b^2. Margins of upper lobes variously dented.
      2. *C. multifidum* (Kuetz.) Manza.
a^2. Branching primarily dichotomous, but ultimately digitate.
      1. *C. africanum* Manza.

CHEILOSPORUM SAGITTATUM (Lamx.) Areschoug. Plate 9.

Cheilosporum sagittatum (Lamx.) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 545.

Corallina sagittata LAMOUROUX in Freycinet, Zool. 3 (1824) 625, pl. 95, figs. 11, 12.

Amphiroa (*Cheilosporum*) *sagittatum* DECAISNE, Mem. sur les Corallines (1842) 113.

Amphiroa sagittata DECAISNE in Harvey, Ner. Austr. (1847) 102.

Fronds erect, 3 cm long; branching generally dichotomous; intergenicula near base cylindrical, about 0.5 mm long and 0.5 mm broad, on upper parts compressed, sagittate, lobe acute, about 1 mm long and 1 to 1.5 mm broad; tetrasporic conceptacles single

on upper margins of upper lobes of intergenicula. Cystocarpic and antheridial plants unknown.

Type: *Corallina sagittata* Lamouroux.

Type locality: "Île-de-France." Descriptions based on specimens in Herb. Univ. Calif.

Cheilosporum sagittatum (Lamx.) Areschoug appears not to have been studied to any considerable extent. It was first described by Lamouroux as *Corallina sagittata,* as follows: "*Corallina* dichotoma; articulis sagittatis, extremitatibus acutis vel ovariiferis." Decaisne merely listed this species as *Amphiroa* (*Cheilosporum*) *sagittata,* and Harvey referred it to *Amphiroa sagittata* under the section *Cheilosporum,* merely quoting the original description. Areschoug, on the other hand, elaborately described this species as follows:

> Fronde robusta 4 mm lata stipitata apice subdilatata, articulis mediis ramorumque subsagittatis basi attenuato-obovatis, longitudine intergenicula distantiam loborum 1, sesquilongiori, lobis patentibus subulato-acutis 1. obtusiusculis remotis keramidiis subsolitariis.

South African plants (sent by Comm. Dr. A. V. Duthie) reasonably resembling the type illustrated by Lamouroux, are about 3 cm high, with dichotomous branching, and the conceptacles borne singly on the upper margins of the upper lobes of the intergenicula.

Under *Cheilosporum* a considerable number of additional species have been proposed, of which only 5 described thus far may be satisfactorily referred to this genus. They are:

CHEILOSPORUM CULTRATUM (Harvey) Areschoug.

Cheilosporum cultratum (Harvey) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 545, 546; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 18.

Amphiroa cultrata HARVEY, Ner. Austr. (1847) 102, pl. 39, figs. 1–3.

Fronds 4 cm long; branching dichotomous; segments near base cylindrical, slender, proliferous, intergenicula about 0.5 mm long and 0.5 mm in diameter; on upper parts compressed, intergenicula sagittate, midrib prominent, lobes acute, about 1.5 mm long and 2 to 3 mm broad; conceptacles on upper margins of upper lobes of intergenicula 1 to 3, but generally 2 on each lobe.

Type: *Amphiroa cultrata* Harvey (may be in Herb. British Museum).

As the type was not available for study, the foregoing description is based on South African plants reasonably resembling the figures of Harvey. (10, pl. 39, figs. 1–3) This species was first re-

ferred to species of *Amphiroa*, but under the present generic restrictions it shows all the essential characters of species of *Cheilosporum* and not of species of *Amphiroa;* such as, genicula unizonal; intergenicular medullary filaments straight, cells in zones of equal length; conceptacles on upper margins of upper lobes of intergenicula.

CHEILOSPORUM AFRICANUM Manza.

Cheilosporum africanum MANZA, Proc. Nat. Acad. Sci. (11) 23 (1937) 570, 571.

Fronds 5 to 8 cm long; primary branching dichotomous, secondary lateral, divisions dichotomous or subpinnate, ultimate branchlets borne digitately; segments near base tapering downward, intergenicula cylindrical, 1 mm long and 1 to 1.5 mm broad, on upper parts compressed, on ultimate branchlets slender; intergenicula on primary branches obcordate, lobes acute; intergenicula on branchlets obcordate, lobes acuminate; 1 to 2 mm long and 1 to 3 mm broad; tetrasporic conceptacles on upper margins of upper lobes of intergenicula borne singly near axis, pores apical-marginal.

Type: tetrasporic, *Herb. Univ. Calif. No. 564605;* Still Bay, South Africa. Collected by Ecol. Surv. *S. B. 80.*

CHEILOSPORUM MULTIFIDUM (Kuetz.) Manza.

Cheilosporum multifidum (Kuetz.) MANZA, Proc. Nat. Acad. Sci. (11) 23 (1937) 571.

Amphiroa multifida KUETZING, Tab. Phyc. 8 (1858) pl. 56, fig. 1.

Fronds 3 to 5 cm long; branching largely dichotomous but sometimes with lateral proliferations; segments on lower parts slender, filiform, proliferous; segments of upper parts compressed, intergenicula obcordate or subobcordate, lobes of intergenicula of lower parts of branches obtuse, acute, or cleft, those near apices fimbriate, 1 mm long, 2 to 4 mm broad; tetrasporic conceptacles on upper margins of intergenicula, borne singly near axils, pores apical-marginal.

Type: *Amphiroa multifida* Kuetzing.

Type locality.—Cape of Good Hope.

CHEILOSPORUM ELEGANS (Hook. f. et Harvey) Areschoug.

Cheilosporum elegans (Hook. f. et Harvey) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 546; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Japan Art. 12 20 (1905) 18.

Amphiroa elegans HOOKER f. et HARVEY in Harvey, Ner. Austr. (1847) 101, 102.

CHEILOSPORUM JUNGERMANNIOIDES (Rupr.) Areschoug.

Cheilosporum jungermannioides (Rupr.) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 546, 547; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 107; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 18.

Available specimens of *Cheilosporum elegans* and *C. jungermannioides* are fragmentary, but to all indications they are species of *Cheilosporum* as the genus is restricted and not species of *Amphiroa* to which they were referred previously. In our specimens the genicula are unizonal, the intergenicular medullary filaments straight, with cells in zones of equal length and the conceptacles on the upper margins of the upper lobes of the intergenicula, which are characters of species of *Cheilosporum* as the genus is restricted.

8. Genus LITHOTHRIX Gray

Lithothrix GRAY, Journ. Bot. 5 (1867) 33, figs. *a*, *b*.

Fronds fragile; branching pinnate, or dichotomous-pinnate; genicula unizonal; intergenicular medulla unizonal; conceptacles lateral, scattered over surfaces of intergenicula.

Type species: *Lithothrix Aspergillum* Gray.

In 1867 J. E. Gray proposed a monotypic genus, *Lithothrix*, naming the single species *Lithothrix Aspergillum* Gray. In 1904 Weber van-Bosse (32, pp. 86, 108, 109) and Yendo in 1905 (38, pp. 1, 2, 14–16) adopted the genus and recognized *Lithothrix Aspergillum* as the type species. It seems best to follow Gray, Weber van-Bosse, and Yendo in the present paper.

The genus *Lithothrix*, according to Gray, includes practically all species of the articulated corallines with pinnate branching and with conceptacles scattered over the surfaces of the intergenicula. Weber van-Bosse restricted the genus to species with "calcified constrictions replacing the nodes and the central strand of the joints consisting of long undivided noncalcified filaments standing in vertical rows and the 'conceptacula' on the joints." According to Yendo (38, pp. 1, 2) *Lithothrix* includes species with the propagating cells generated from the medulla and the genicula not well differentiated. The characterization of Weber van-Bosse, (32, p. 86) "calcified constrictions replacing the nodes," seems to mean that species of *Lithothrix* have no genicula (nodes) in the proper sense. These so-called "calcified constrictions," according to our findings, occur in similar succession as the genicula and the intergenicula of the other species of the

articulated corallines, their structure varying in the same fashion with the structure of the genicula and of the intergenicula of the other species of this group, so that in this account they will be called genicula. In the figures of the type provided by Gray, and in the type specimen (in Herb. Brit. Museum), there is no difficulty in determining a large number of plants as being *Lithothrix Aspergillum* Gray. It seems proper to delimit *Lithothrix* to species fundamentally with conceptacles lateral, scattered over the surfaces of the intergenicula; with genicula unizonal; and with the intergenicular medulla unizonal.

Species of *Lithothrix* resemble certain species of *Amphiroa* in the shape of the segments and in the position of the conceptacles. In species of *Lithothrix,* however, the segments are generally cylindrical, like in species of *Amphiroa,* and the conceptacles are lateral and borne on the surfaces of the intergenicula in similar fashion as those of certain species of *Amphiroa.* They differ from species of *Amphiroa,* however, in the modes of branching and in the microscopic structure of the genicula and of the intergenicula. In *Amphiroa* branching is strictly dichotomous, while in *Lithothrix* it is largely pinnate; in *Amphiroa* the genicula generally are multizonal, the intergenicular medulla multizonal with straight filaments, and the cells arranged in long and short transverse zones; while in *Lithothrix* the genicula and the intergenicular medullæ are unizonal, and the genicular cells are comparatively many times shorter than those of the intergenicular medullary cells.

LITHOTHRIX ASPERGILLUM (Gray) **Anderson. Plate 10, figs. 1 and 2.**

Lithothrix Aspergillum (Gray) ANDERSON, Zoe 2 (1891) 225.
Amphiroa nodulosa FARL., Report U. S. Fish. Comm. (1875) 715.
Amphiroa nodulosa COLL. in Hold. et Sechell, Phyc. Bor. Amer. fasc. 10 (498) (1898).
Amphiroa Aspergillum fo. *nana* SETCH. et GARD., Alg. N. W. A. (1903) 359.

Fronds erect, 8 to 13 cm long; primary branching dichotomous, ultimately lateral; intergenicula near base cylindrical, 0.5 mm long and 0.5 to 1 mm in diameter, on upper parts and on primary branches cylindrical or slightly compressed, 1 mm long and 1 to 1.5 mm broad, on ultimate branches cylindrical and very slender; genicular cells many times shorter than intergenicular medullary cells; tetrasporic conceptacles conical, scattered over surfaces of intergenicula, with pores central and tetrasporangia basal. Cystocarpic and antheridial plants unknown.

Type: *Lithothrix Aspergillum* Gray.

Type locality.—"Vancouver's Island."

Specimens of this species have been collected from the northwestern coast of North America and likewise from the coast of southern California.

Lithothrix Aspergillum, according to Gray, has conceptacles scattered over the surfaces of the intergenicula; pinnate branching; short intergenicula, compressed near the upper parts of the main branches and cylindrical on the branchlets. Weber van-Bosse merely states that the species bears the same diagnosis as the genus. Our plants showing characters that can be ascribed to the type specimen have extremely short segments; the main axis dividing dichotomously, the divisions in turn sending out slender unbranched lateral proliferations arranged in pinnate and alternate fashion. The conceptacles are conical and protrude most evidently on the surfaces of the intergenicula. In addition, the cells of the so-called genicula in this species are 4 or more times shorter than the cells of the intergenicular medulla.

9. Genus AMPHIROA Lamx. (emend. Weber van-Bosse)

Amphiroa LAMOUROUX, Nouv. Bull. des Sci. Soc. Philomat. 3 (1812) 186; Hist. Polyp. Flex. (1816) 294–302; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 86–101.

Fronds extremely fragile; branching dichotomous, rarely irregular-dichotomous; genicula unizonal or multizonal; intergenicular medullary filaments straight, with cells always in long and short transverse zones; conceptacles lateral, scattered over surfaces of intergenicula.

Type species: *Amphiroa fragilissima* (Linn.) Lamouroux.

A considerable number of species have been referred to this genus, of which only 17 seem to have been properly established. These species have thus far been recorded from all tropical and subtropical shores.

In 1812 Lamouroux established the genus *Amphiroa* and listed under it 2 species, *Amphiroa tribulus* Lamx. and *A. cuspidata* Lamx. [synonym of *Amphiroa fragilissima* (L.) Lamx.]. In 1816 he described 13 species, including *Amphiroa rigida* Lamx., *A. tribulus, A. cuspidata,* and *A. fragilissima* (L.) Lamx. In 1842 Decaisne listed 23 species and practically established *Amphiroa fragilissima* (L.) Lamouroux and *A. cuspidata* Lamouroux as typical species of *Amphiroa* by including them under the section *Euamphiroa,* and by placing *Amphiroa tribulus* under

the section *Eurytion* and excluding *Amphiroa rigida* entirely from his list. In 1852 Areschoug included *Amphiroa fragilissima, A. cuspidata, A. rigida,* and *A. tribulus* among 14 others, a considerable number of which may still be referred properly to *Amphiroa* as restricted. In 1897 Schmitz and Hauptfleisch (28, pp. 542, 543) designated *Amphiroa rigida* as the type of *Amphiroa,* although it was not mentioned by Lamouroux in his original paper. Weber van-Bosse listed 17 species, including *A. fragilissima, A. tribulus,* and *A. rigida,* and referred *A. cuspidata* to *A. fragilissima;* while Yendo in 1905 likewise listed *A. fragilissima, A. tribulus,* and *A. rigida,* referring *A. cuspidata* as a form of *A. fragilissima,* and adopted these species as typical species of *Amphiroa,* since he listed them under the section *Euamphiroa,* limited to species of *Amphiroa* as the genus is restricted. Of these species, *Amphiroa fragilissima* (Linn.) Lamx. may be adopted as the type of the genus, although Schmitz and Hauptfleisch designated *A. rigida* Lamx. as the type of *Amphiroa,* not only because *Amphiroa fragilissima* (Linn.) Lamx. (syn. *A. cuspidata* Lamx.) is one of the 2 species first established by Lamouroux when he established the genus *Amphiroa,* since Lamouroux did not even mention *Amphiroa rigida* in his earlier account. In addition, this species, *Amphiroa fragilissima,* practically because the author listed it under *Euamphiroa,* but not technically because he did not definitely say so, has been adopted as the type of *Amphiroa* by Decaisne as early as 1842, listed under *Euamphiroa,* while *A. tribulus* was listed under *Eurytion,* and *Amphiroa fragilissima* is one of the species of *Amphiroa* seemingly recognized by all authors as typical *Amphiroa.* Even Yendo, who adopted a broad application of *Amphiroa,* recognized *Amphiroa fragilissima* (Linn.) Lamx. as typical *Amphiroa,* since he listed it under *Euamphiroa,* the content of which, according to our concept of the genus as limited, is still typical *Amphiroa.*

Differences of opinion have long existed with regard to the limitation of *Amphiroa.* Lamouroux states that *Amphiroa* has branching dichotomous, trichotomous, or verticillate, articuli long, separated one from the other by a naked and horny substance. According to Decaisne it includes species with conceptacles scattered over the surfaces of the intergenicula. Areschoug, who characterized *Amphiroa* in almost the same fashion as Decaisne, further limited it by elevating *Arthrocardia* and *Cheilosporum,* two subgenera of Decaisne, to independent genera.

Weber van-Bosse further limited this genus by including under it species with conceptacles scattered over the "joint," genicula unizonal or multizonal, intergenicular medullary filaments straight, and cells in long and short transverse zones. Yendo, however, extended the application of *Amphiroa* by including under it sections *Arthrocardia* and *Marginosporum*, which include species not referrable to *Amphiroa* as restricted by Weber van-Bosse. In species properly referrable to *Amphiroa* the conceptacles are always lateral and scattered over the surfaces of the intergenicula, the genicula are either unizonal or multizonal, and the intergenicular medullary filaments are straight, with cells in long and short transverse zones, so that it seems proper to delimit the genus *Amphiroa* to species showing those essential characters.

AMPHIROA FRAGILISSIMA (Linn.) Lamouroux.

Corallina fragilissima LINNÆUS, Syst. Nat. ed. 12 pt. 2 1 (1767) 1305.

Amphiroa cuspidata LAMOUROUX, Nouv. Bull. Sci. Soc. Philomat. 3 (1812) 186; Hist. Polyp. Flex. (1816) 300; DECAISNE, Mem. sur les Corallines (1842) 112; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 531; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 89.

Amphiroa fragilissima fo. *cuspidata* YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 3.

Fronds slender, about 4 cm long; branching strictly dichotomous, with branches arising from genicula; intergenicula cylindrical, with swollen ends in older ones, about 4 mm long and 0.5 mm in diameter, tetrasporic conceptacles semiglobular, scattered over surfaces of intergenicula, pores central and tetrasporangia basal. Cystocarpic and antheridial plants unknown.

Type: *Corallina fragilissima* Linnæus.

Type locality.—"O. Americano."

Amphiroa fragilissima was first described as *Corallina fragilissima* Linnæus, primarily recognizable by its filiform articuli and dichotomous branching. According to Lamouroux, *Amphiroa fragilissima* has branching dichotomous, branches capillary, and articuli cylindrical and with swollen extremities. Areschoug described *Amphiroa fragilissima* (Linn.) Lamx. as follows:

Fronde pulvinato-caespitosa ultra-setacea subirregulariter dichotoma, articulis cylindraceis utraque extremitate nodoso-tumescentibus diametro 6 plo–10 plo longioribus, ultimis apice obtusiusculis, geniculis lineaeformibus.

Weber van-Bosse, on examination of the type of *Amphiroa fragilissima* of Lamouroux, gives the following description:

Fronds articulated, cylindrical, branched at the node di- or trichotomously, often with adventitious branches. Joints long, many times longer than broad, in older specimens swollen at top and base in the form of a ball or pad by local divisions in longitudinal and vertical direction of the cells of the cortical layer. Nodes swollen, cushionlike in conformity with the swollen tops and bases of the joints. Central strand built up of 4 to 8 rows of long cells, seldom 2 or 3 rows of long cells, mostly 4 rows, followed by one row or two rows of short cells.

Our specimens reasonably resemble the Linnæan type, of which we have excellent photographs. The fronds are slender, with branching strictly dichotomous, branches arising from the genicula, with each geniculum bearing branches, with all the ends of the intergenicula on the older portions swollen, and with conceptacles scattered over the surfaces of the intergenicula.

Species of *Amphiroa* have been studied very thoroughly by Weber van-Bosse.(32, pp. 86–101) Of a considerable number of species included under *Amphiroa*, there seem to be only 16 additional fairly well established species.

AMPHIROA TRIBULUS Lamouroux.

Amphiroa tribulus LAMOUROUX, Nouv. Bull. des Sci. Soc. Philomat. 3 (1812) 86; Hist. Polyp. Flex. (1816) 301, 302; DECAISNE, Mem. sur les Corallines (1842) 113; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 534; YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 3; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99.

AMPHIROA CRASSA Lamouroux.

Amphiroa crassa LAMOUROUX in Decaisne, Mem. sur les Corallines (1842) 112; HARVEY, Ner. Austr. (1847) 97; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Journ. Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 5.

AMPHIROA CANALICULATA von Mart.

Amphiroa canaliculata VON MART. in Weber van-Bosse, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Journ. Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 5.

AMPHIROA INVOLUTA Kuetzing.

Amphiroa involuta KUETZING, Tab. Phyc. 8 (1858) 23, pl. 48, fig. 2, *e–g;* WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Journ. Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 3.

AMPHIROA ANCEPS (Lamk.) Decaisne. Plate 11, figs. 1 and 2.

Amphiroa anceps (Lamk.) DECAISNE, Mem. sur les Corallines (1842) 113; HARVEY, Ner. Austr. (1847) 98; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 536, 537; KUETZING, Tab. Phyc. 8 (1858) 24, pl. 49, fig. 4, *f–h;* WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Journ. Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 4.

AMPHIROA BOWERBANKII Harvey.

Amphiroa Bowerbankii HARVEY, Ner. Austr. (1847) 97, pl. 37, figs. 1–6; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 5.

AMPHIROA BEAUVOISII Lamouroux.

Amphiroa Beauvoisii LAMOUROUX, Hist. Polyp. Flex. (1816) 299; KUETZING, Tab. Phyc. 8 (1858) 21, pl. 44, fig. 1, *a–d;* WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 4.

AMPHIROA EPHEDRAEA (Lamk.) Decaisne.

Amphiroa ephedraea (Lamk.) DECAISNE, Mem. sur les Corallines (1842) 112; HARVEY, Ner. Austr. (1847) 95, pl. 39, figs. 1–4; ARESCHOUG in Agardh, Sp. Alg. pt. 2 2 (1852) 534; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99; YENDO, Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 4.

AMPHIROA LINEARIS Kuetzing.

Amphiroa linearis KUETZING, Tab. Phyc. 8 (1858) 22, pl. 46, fig. 2, *a–c;* WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 99.

AMPHIROA ANASTOMOSANS Weber van-Bosse.

Amphiroa anastomosans WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 100.

AMPHIROA FOLICEA Lamouroux.

Amphiroa foliacea LAMOUROUX in Freycinet, Voyage Autour du Monde Zoöl. 3 (1824) 628, pl. 93, figs. 2, 3; WEBER VAN-BOSSE. Sib. Exp. Monogr. 61 (1904) 100; YENDO, Coll. Imp. Univ. Tokyo Art. 12 20 (1905) 5.

AMPHIROA VALONIOIDES Yendo.

Amphiroa valonioides YENDO, Corallinae verae Japonicae. Journ. Coll. Sci. Imp. Univ. Tokyo Art. 3 16 (1902) 5, pl. 1, figs. 1–3; pl. 4, fig. 1; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 100; YENDO, A Revised List of Corallinae. Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 2.

AMPHIROA VERRUCOSA Lamouroux.

Amphiroa verrucosa LAMOUROUX, Hist. Polyp. Flex. (1816) 300; DECAISNE, Mem. sur les Corallines (1842) 112; KUETZING, Tab. Phyc. 8 (1858) 20, pl. 42, fig. 3; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 100.

AMPHIROA RIGIDA Lamouroux.

Amphiroa rigida LAMOUROUX, Hist. Polyp. Flex. (1816) 297; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 532; WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 100; YENDO, Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 3.

AMPHIROA NODULOSA Kuetzing.

Amphiroa nodulosa KUETZING, Tab. Phyc. 8 (1858) 19, pl. 41, fig. 1; WEBER VAN BOSSE, Sib. Exp. Monogr. 61 (1904) 100; YENDO, Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 4.

AMPHIROA DUBIA Kuetzing.

Amphiroa dubia KUETZING, Tab. Phyc 8 (1858) 24, pl. 49, fig. 1, *a–c;* WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 100.

Specimens referred to the foregoing species on examination all showed essential specific characters of *Amphiroa;* such as genicula multizonal, intergenicular medullary filaments straight with zones of long and short cells, and conceptacles lateral on the surfaces of the intergenicula. These species are, likewise, recognized by a considerable number of authors as species of *Amphiroa,* among them Weber van-Bosse,(32) who restricted the genus in a fashion similar to the restriction of the genus in the present paper. Accurate descriptions of these species could not be prepared at this time as available specimens are merely fragments of segments. Consequently they are merely listed under *Amphiroa.*

10. Genus BOSSEA Manza

Bossea MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 46.

Fronds fragile; branching dichotomous, pinnate or pinnate-dichotomous; segments near base cylindrical or compressed, on upper parts compressed; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles semiglobular or conical, scattered over surfaces of intergenicula.

Type species: *Bossea plumosa* Manza.

According to all indications species of this genus occur only on temperate and subtropical shores. A large number of specimens of a number of properly identified and described species of this genus have been collected from the coast of California by Profs. W. A. Setchell and N. L. Gardner and by myself. Decaisne(6, p. 112) reported 2 species, *Amphiroa* (*Arthrocardia*) *Orbigniana,* attributed to San Carlos, coast of Chile, and *Amphiroa* (*Arthrocardia*) *californica,* attributed to the coast of California (Monterey).

Seven additional species of *Bossea* are known with reasonable certainty, some of them previously described as species of *Amphiroa* or of *Cheilosporum*. In the position of the conceptacles, species of *Bossea* are similar to species of *Amphiroa*, all conceptacles in both groups being restricted to the flat surfaces of the intergenicula. Species of these 2 genera differ, however, in the microscopic structure of the genicula and of the intergenicula: in *Amphiroa* the genicula are mostly multizonal, and the intergenicular medullary filaments straight, with cells in long and short transverse zones; in *Bossea* all genicula are unizonal and the intergenicular medullary filaments are likewise straight, but the cells are in transverse zones of equal length. In addition, practically all species of *Amphiroa* have dichotomous branching, while in *Bossea* most species have pinnate branching. In the structure of the genicula and of the intergenicula, species of *Bossea* and of *Cheilosporum* are similar, both having unizonal genicula, and intergenicular medullary filaments are straight, with cells in transverse zones of equal length. The 2 genera differ primarily in the position of the conceptacles. In *Bossea* the conceptacles are on the flat surfaces of the intergenicula, and in *Cheilosporum*, according to our restriction of this genus, they are on the upper margins of the upper lobes of the intergenicula.

Key to the species of Bossea.

a^1. Branching pinnate.
  b^1. Branches almost of same height .... 1. *B. corymbifera* Manza.
  b^2. Branches not of same height.
    c^1. Young branches or branchlets ovate .... 2. *B. frondifera* Manza.
    c^2. Young branches or branchlets elongated.
      d^1. Branches arising in zones which are separated by zones without branches .... 3. *B. interrupta* Manza.
      d^2. Branches arising from almost all intergenicula.
        4. *B. plumosa* Manza.
a^2. Branching wholly or partially dichotomous.
  b^1. Branching dichotomous.
    c^1. Intergenicula with upper lobes mostly acute.
      5. *B. Orbigniana* (Decne.) Manza.
    c^2. Intergenicula with upper lobes mostly obtuse.
      6. *B. Gardneri* Manza.
  b^2. Branching partly dichotomous.
    c^1. Primary branching dichotomous, ultimately digitate.
      7. *B. californica* (Decne.) Manza.
    c^2. Primary branching pinnate, ultimately dichotomous.
      8. *B. dichotoma* Manza.

BOSSEA PLUMOSA Manza. Plate 12, figs. 1 and 2.

Bossea plumosa MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 46.

Fronds erect, 3 to 6 cm long; branching plumosely bi- or tripinnate and opposite, branches on lower parts short ramules, on upper parts long branches once or twice pinnately divided with divisions short on lower parts, long on upper parts; intergenicula near base slightly compressed, 1 mm long and 1 mm broad, on upper parts on primary branches comparatively thick, compressed-cuneate, 1 mm long and 2 mm broad, on branchlets thin, compressed-cuneate or obcordate with obtuse lobes 1 mm long and 2 mm broad, on ramules spathulate, 1 to 2 mm long and 0.5 to 1 mm broad; conceptacles conical on flat surfaces of intergenicula, 2 to 4, mostly 2 on each flat surface, borne singly or in pairs on each wing and arranged in vertical rows along axis, single and central on flat surfaces of ramules, with pores central and tetrasporangia basal. Cystocarpic and antheridial plants unknown.

Type: *Bossea plumosa* Manza, tetrasporic, Moss Beach, coast of Central California, west coast of North America (*Herb. Univ. Calif. No. 545710*).

Bossea plumosa is the most characteristic species of the genus. The fronds appear like feathers, having decidedly and comparatively thick axes with slender and flexible lateral divisions. The basal segments are cylindrical or slightly compressed, with the segments above thicker and more compressed. The lateral divisions consist of ramules and long branches, the simple ramules are always situated near the base of the primary axes of the fronds and near the bases of the branches or branchlets, while the long compound branches or branchlets in each case occur above them.

Seven additional species described thus far may be referrable to this genus. They are:

BOSSEA ORBIGNIANA (Decne.) Manza.

Bossea Orbigniana (Decne.) MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 563, 564.

Amphiroa (*Arthrocardia*) *Orbigniana* DECAISNE, Mem. sur les Corallines (1842) 112.

Amphiroa Orbigniana DECAISNE in Harvey, Ner. Austr. (1847) 100; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 539.

Cheilosporum Orbignianum (Decne.) YENDO, A Revised List of Corallinae. Journ. Coll. Sci. Imp. Univ. Tokyo, Art. 12 20 (1905) 20.

Fronds 7 to 21 cm long; branching wholly or partially dichotomous; intergenicula near base cylindrical, 1 to 2 mm long and 2 mm broad, intergenicula on upper parts compressed-cuneate with lobes acute, or obcordate with lobes obtuse, 2 mm long, 2 to

3 mm broad; tetrasporic conceptacles conical, on flat surfaces of intergenicula, 2 on each surface borne singly on each wing near upper margin of lobe, very close to midrib, pores central, tetraspores basal.

Type: *Amphiroa* (*Arthrocardia*) *Orbigniana* Decaisne.

Type locality.—"Patagonia S. Carlos Chiloensisque littora."

The type specimen is not available for examination, but in our collection of the articulated corallines we have plants referred to this species and showing characters consistent with the type.

BOSSEA CALIFORNICA (Decne.) Manza.

Bossea californica (Decne.) MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 561, 562.
Amphiroa (*Arthrocardia*) *californica* DECAISNE, Mem. sur les Corallines (1842) 112.
Cheilosporum californicum YENDO, a revised list of Corallinae. Journ. Coll. Sci. Imp. Univ. Tokyo 20 (1905) 19.

Fronds 5 to 12 cm long; branching dichotomous-digitate-cymoid; intergenicula near base thick, cylindrical, 1 to 3 mm long, 2 mm broad, intergenicula of upper parts thick, compressed, mostly obcordate, with lobes rounded, 2 to 5 mm long and 2 to 6 mm broad; tetrasporic conceptacles on flat surfaces of intergenicula, 2 to 8, mostly 6, on each surface, arranged in rows along lateral margins, 2 to 4 on each side, pores central.

Type: *Amphiroa* (*Arthrocardia*) *californica* Decne. Topotype: tetrasporic, *Herb. Univ. Calif. No. 266290.*

Type locality.—"California (Monterey)."

The type of this species not being available for study, specific descriptions have been based on topotypes. According to the present generic limitations, this species bears essential characters of *Bossea* and not of any one of the other genera to which it has hitherto been referred.

BOSSEA CORYMBIFERA Manza. Plate 13.

Bossea corymbifera MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 562.

Fronds 3 to 5 cm long; branching bi-, tri-, or pentacotomose-corymboid; intergenicula near base thick, cylindrical, 1 to 2 mm long, 1 mm broad, on upper parts compressed, thick, cuneate or obcordate, with lobes obtuse, 1 to 2 mm long and 2 to 3 mm broad; conceptacles semiglobular on flat surfaces of intergenicula, 2 to 4 on each surface, 1 or 2 on each wing arranged in vertical rows along axis, with pores central and tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 545752;* Point Lobos, Carmel Bay, coast of central California, west coast of North America. Collected by A. V. Manza.

BOSSEA FRONDIFERA Manza. Plate 14.

Bossea frondifera MANZA, Proc. Nat. Acad. Sci. 23 (1937) 562, 563.

Fronds 2 to 7 cm long; branching plumosely pinnate and opposite or pinnately decompound, young branches ovate; intergenicula near base cylindrical, 1 mm long, 1 mm broad, on upper parts cuneate or obcordate, 1 to 2 mm long, 1 to 3 mm broad with lobes obtuse; tetrasporic conceptacles conical, 2 on each surface of intergeniculum, borne singly near upper lobes, pore central, tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 545757;* Moss Beach, San Mateo County, coast of central California, west coast of North America. Collected by A. V. Manza.

BOSSEA GARDNERI Manza. Plate 15.

Bossea Gardneri MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 563.

Fronds 5 to 18 cm long; branching dichotomous, or primary branching lateral but ultimately dichotomous; intergenicula near base slender, cylindrical or slightly compressed, 1 mm long, 1 mm broad, on upper parts on primary branches cuneate, 1 to 2 mm long, 1 to 3 mm broad, with lobes obtuse, on branchlets obcordate with thin wings and prominent midrib, 2 to 3 mm long, 2 to 4 mm broad; tetrasporic conceptacles semiglobular, 2 to 6 (mostly 4) on flat surfaces, 1 to 3 on each wing arranged in rows along midrib, pores central, tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 545763;* Pacific Grove, Monterey County, coast of central California, west coast of North America. Collected by N. L. Gardner.

BOSSEA INTERRUPTA Manza. Plate 16.

Bossea interrupta MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 563.

Fronds 5 to 13 cm long; branching bi- or tripinnate and opposite, branches arising in groups separated from one another by segments bearing simple branchlets; intergenicula near base thick, cylindrical, 1 to 2 mm long, 2 mm in diameter, on upper parts on primary branches compressed-obcordate, with thin wings and lobes obtuse, 2 mm long, 2 to 4 mm broad, on branchlets spathulate, 3 mm long, 1 to 2 mm broad; tetrasporic concep-

tacles semiglobular, on flat surfaces of intergenicula, 2 on each flat surface borne singly on each wing near upper margins of lobes, very close to midrib, and on ramules borne singly on central part, pores central, tetraspores basal.

Type: tetrasporic, *Herb. Univ. Calif. No. 545969;* Pacific Grove, Monterey County, coast of central California, west coast of North America. Collected by A. V. Manza.

BOSSEA DICHOTOMA Manza. Plate 17.

Bossea dichotoma MANZA, Proc. Nat. Acad. Sci. U. S. A. 23 (1937) 562.

Fronds 6 to 12 cm long; primary branching pinnate to subalternate, ultimately dichotomous; intergenicula near base slender, compressed, 1 to 2 mm long, 1.5 mm broad, on upper parts compressed-cuneate to subcordate, 2 to 3 mm long, 2 to 6 mm broad, with lobes rounded; tetrasporic conceptacles semiglobular, on flat surfaces of intergenicula, 2 to 4 (usually 2) on each flat surface, borne singly or in pairs arranged in vertical rows along axis, pores central, tetraspores basal.

Type specimen: tetrasporic, *Herb. Univ. Calif. No. 545756;* Moss Beach, San Mateo County, coast of central California, west coast of North America. Collected by A. V. Manza.

11. Genus PACHYARTHRON Manza

Pachyarthron MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 45.

Fronds fragile; branching dichotomous or irregular-dichotomous; segments cylindrical or slightly compressed; genicula unizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles semiglobular, scattered over surfaces of intergenicula.

Type species: *Pachyarthron cretaceum* (P. et R.) Manza.

At present *Pachyarthron* appears to be a monotypic genus, the only species known being *Pachyarthron cretaceum,* which is recorded only from cold parts of north Pacific coasts. It has been collected from Unalaschka (the type locality), Saint Lawrence Island, and Japan (Rikuzen, Hakkodate, and Otaru Provinces; Rishira Island). This genus is more closely related to *Amphiroa* than to *Corallina* or *Arthrocardia,* to which the species has been previously referred. In habit it shows all characters ascribed to species of *Amphiroa,* having wholly or partially dichotomous branching and the position of the conceptacles scattered over the surfaces of the intergenicula. *Amphiroa* and

Pachyarthron differ merely in microscopic structure of the genicula and of the intergenicula.(22, p. 45) The type specimen made available through the courtesy of Dr. Anna Weber van-Bosse shows characters different from any one of the genera to which the species has previously been referred. Species of *Pachyarthron* differ from species of *Amphiroa* in that the genicula are unizonal and the intergenicular medullary filaments straight with cells in zones of equal length; while in species of *Amphiroa* the genicula are mostly multizonal and intergenicular, and the medullary filaments are straight, with transverse zones of long and short cells. Species of *Pachyarthron* differ from species of *Corallina* and *Arthrocardia* primarily in the positions of the conceptacles, which in *Pachyarthron* are scattered over the surfaces of the intergenicula, and in *Corallina* and *Arthrocardia*, terminal.(22)

PACHYARTHRON CRETACEUM (P. et R.) Manza. Plate 18.

Pachyarthron cretaceum (P. et R.) MANZA, Proc. Nat. Acad. Sci. U. S. A. (2) 23 (1937) 45.

Corallina cretacea P. ET R., Ill. 40 (1840) 20, fig. 104.

Amphiroa cretacea (P. et R.) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 533.

Amphiroa cretacea ENDL. in Kuetzing, Tab. Phyc. 8 (1858) 22, pl. 45, figs. *a–f;* YENDO, Corallinae Japonicae. Journ. Coll. Sci. Imp. Univ. Tokyo pt. 3 16 (1902) 7, pl. 1, fig. 4; pl. 4, fig. 2; A revised list of Corallinae. Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 10.

Arthrocardia cretacea (P. et R.) WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 105, pl. 15, fig. 8.

Fronds erect, 5 to 6 cm long; branching dichotomous or irregular-dichotomous; intergenicula near base cylindrical, 2 to 3 mm long and 1 to 2 mm in diameter, on upper parts on primary branches cylindrical or slightly compressed, on ultimate branchlets cylindrical, with apices slightly tapering, 2 to 4 mm long and 1 to 3 mm in diameter; tetrasporic conceptacles semiglobular, scattered over surfaces of intergenicula, pores central, tetraspores basal. Cystocarpic and antheridial plants unknown.

Type: *Corallina cretacea* P. et R.

A large number of plants collected from Unalaschka by Prof. W. A. Setchell, from Saint Lawrence Island, by Otto Geist in 1931, and from Japan (Rikuzen, Hakkodate, and Otaru Provinces; Rishira Island) by Yendo, agree in all essential characters with the type fragments. Only the plants collected from Saint Lawrence Island are whole plants, all the rest being fragments,

and our specific diagnosis is based upon them. Practically all the segments are cylindrical, except those on the central parts where they are sometimes slightly compressed; the basal segments slightly tapering downwards; and the ultimate branches slightly tapering upwards. It appears that the normal branching is dichotomous and the lateral branches normally occurring are merely nontypical proliferations.

12. Genus METAGONIOLITHON Weber van-Bosse

Metagoniolithon WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 86, 101–104.

Fronds fragile; branching verticillate, dichotomous or verticillate-dichotomous, with branches arising from cortex of genicula, and with apices covered with a mucilaginous cap; genicula multizonal; intergenicular medullary filaments straight, with cells in transverse zones of equal length; conceptacles lateral, scattered over surfaces of intergenicula or restricted on lower side of branches.

Type species: *Metagoniolithon charoides* (Lamx.) Weber van-Bosse.

Four species have been described as belonging to *Metagoniolithon*. Specimens have been recorded from the coast of Australia only, and it appears that the species of *Metagoniolithon* are strictly Australian, with their distribution subtropical.

Weber van-Bosse proposed the genus *Metagoniolithon* and referred to it 3 species, *M. charoides, M. graniferum,* and *M. stelligerum.* In 1905 Yendo (38, pp. 1, 12, 14) adopted the genus but recognized only 2 species of Weber van-Bosse, *M. charoides* and *M. stelligerum,* in addition to his *M. gracile*, and listed *M. graniferum* as species inquirenda. Weber van-Bosse first mentioned *M. charoides,* which was likewise mentioned first by Yendo, so that it seems to have been recognized by these authors as the type of the genus.

The genus *Metagoniolithon* as defined by Weber van-Bosse includes species with

Joints cylindrical; in the central strand, the cells have throughout the whole joint almost the same dimension and stand vertically one above the other; nodes consist of many rows of cells which are much smaller and have thicker walls than the cells in the joint; conceptacula on the joints.

According to Yendo the genus comprises species with mother cells of the propagating cells generated in the medulla; genicula multizonal; ramuli starting from genicula; articuli cylindrical;

and branching verticillate. Fragments of the type specimen and a large number of species in our collections that are properly referable to *Metagoniolithon,* made available through the courtesy of the different European herbaria [from the Herbarium of the Museum of Paris, *Amphiroa ephedraea, Corallina stelligera, A. jubata* Lamx.; from the Herbarium of the British Museum, *A. stelligera, A. charoides, A. granifera* Harvey, *A. intermedia* Harvey; *A. granifera* Harvey, *A. charoides* Lamx. (type), *A. stelligera,* and *A. intermedia* (Lamx.)] have the conceptacles strictly scattered over the surfaces of the intergenicula or on the lower sides of the branches; branching either wholly or partially verticillate, with branches arising from the genicula and apices covered with a mucilaginous cap; genicula multizonal, intergenicular medullary filaments straight, with cells in transverse zones of equal length, so that it seems proper to restrict the genus to species showing those essential characters. The apical envelope of the branches the exact significance of which is not yet understood, appears as a continuous mucilaginous membrane similar to the more complex root cap in the flowering plants.

METAGONIOLITHON CHAROIDES (Lamx.) Weber van-Bosse. Plate 19.

Metagoniolithon charoides (Lamx.) WEBER VAN-BOSSE.
Amphiroa charoides LAMOUROUX, Hist. Polyp. Flex. (1816) 301; DECAISNE, Mem. sur les Corallines (1842) 112; HARVEY, Ner. Austr. (1847) 96; ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 539, 540; KUETZING, Tab. Phyc. 8 (1858) 25, pl. 52, fig. 1, *a–e*.

Fronds erect, 6 cm long; branching verticillate, with branches of simple ramules and long branches once or twice divided with ultimate divisions of simple ramules, arising from genicula, with every geniculum giving rise to branches; intergenicula cylindrical, 1 to 1.5 cm long and 1 to 2 mm in diameter; tetrasporic conceptacles conical, in single horizontal rows on lower sides of ramules. Cystocarpic and antheridial plants unknown.

Type locality.—"Australasie."

Metagoniolithon charoides was first described by Lamouroux as *Amphiroa charoides*, with verticillate branching and tuberculose articuli. Areschoug states:

Fronde breviori tereti, primaria di- trichotoma, ramulis verticillatis, articulis cylindraceis, utraque extremitate nodoso-incrassatis, inferioribus brevioribus, superioribus diametro usque 8 plo longioribus, geniculis diametro vix longioribus, keramidiis ad ramules subsecundia.

According to Weber van-Bosse, it has a slightly flattened "joint," 1 to 3 cm long and up to 2 mm broad; rather short "nodes."

entirely surrounded by pseudowhorls of branches; conceptacles appearing on underside of branches. *Metagoniolithon charoides* (Lamx.) Weber van-Bosse is the largest species thus far known in this genus. The branching is strictly verticillate with the ultimate divisions of simple ramules. In this species, likewise, every geniculum gives rise to branches, and the conceptacles seem restricted on the underside of the ramules.

The following three additional species seem to be properly established:

METAGONIOLITHON GRANIFERUM (Harvey) Weber van-Bosse.

Metagoniolithon graniferum (Harvey) WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 103.

Amphiroa granifera HARVEY, Phyc. Austr. 4 (1862) pl. 230.

METAGONIOLITHON STELLIGERA (Lamk.) Weber van-Bosse. Plate 20.

Metagoniolithon stelligera (Lamk.) WEBER VAN-BOSSE, Sib. Exp. Monogr. 61 (1904) 103; YENDO, A Revised List of Carollinae. Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 12.

Corallina stelligera LAMARCK, Mem. du Mus. 2 (1815) 239.

Amphiroa stelligera (Lamk.) ARESCHOUG in J. G. Agardh, Sp. Alg. pt. 2 2 (1852) 540.

METAGONIOLITHON GRACILE (Harvey) Yendo.

Metagoniolithon gracile (Harvey) YENDO, Journ. Coll. Sci. Imp. Univ. Tokyo Art. 12 20 (1905) 12.

Amphiroa gracile HARVEY, Phyc. Austr. 4 (1862) pl. 231.

Metagoniolithon graniferum, M. stelligera, and *M. gracile* show characters of species of *Metagoniolithon* as restricted; such as conceptacles lateral on surfaces of intergenicula; genicula multizonal; intergenicular medullary filaments straight, with cells in zones of equal length. They do not show characters of species of *Amphiroa,* under which they were generally referred previously. In addition, they are listed as species of *Metagoniolithon* by Weber van-Bosse(32) who founded the genus. Unfortunately, however, available specimens referred to those species are merely fragments of the segments, and therefore unsuitable for specific diagnosis.

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ILLUSTRATIONS

PLATE 1. JOCULATOR PINNATIFOLIUS MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 1.6; *2*, enlarged portions of tetrasporic frond, showing position of conceptacles, × 33.

PLATE 2. CALLIARTHRON CHEILOSPORIOIDES MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 0.5; *2*, antheridial articulated plant, × 0.5; *3*, enlarged portion of articulated frond, showing position of conceptacles, × 5.5.

PLATE 3. CALLIARTHRON PINNULATUM MANZA

Habit of tetrasporic articulated plant, × 1.

PLATE 4. CALLIARTHRON REGENERANS MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 0.3; *2*, habit of antheridial articulated plant, × 0.3; *3*, habit of cystocarpic articulated plant, × 0.5; *4*, longitudinal section of intergenicular medulla, × 118.

PLATE 5. CALLIARTHRON SCHMITTII MANZA

Habit of tetrasporic articulated plant, × 3.

PLATE 6. CALLIARTHRON SETCHELLIAE MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 0.5; *2*, habit of antheridial articulated plant, × 0.5; *3*, habit of cystocarpic articulated plant, × 0.5; *4*, longitudinal section of cystocarpic conceptacle, × 62.5.

PLATE 7. CORALLINA (EUCORALLINA) OFFICINALIS LINNÆUS

FIG. 1. Longitudinal section of geniculum, × 93.5; *2*, longitudinal section of geniculum and intergeniculum, × 39.5; *3*, longitudinal section of intergeniculum, × 134; *4*, longitudinal section of tetrasporic conceptacle, × 101.5; *5*, longitudinal section of antheridial conceptacle, × 101.5.

PLATE 8. DUTHIEA SETCHELLII MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 1.8; *2*, enlarged portion of articulated frond, showing conceptacle, × 82.8.

PLATE 9. CHEILOSPORUM SAGITTATUM (LAMX.) ARESCHOUG

Habit of tetrasporic articulated fronds, × 3.

PLATE 10. LITHOTHRIX ASPERGILLUM GRAY

FIG. 1. Habit of tetrasporic articulated plant, × 0.7; *2*, longitudinal section of segments, × 92.5.

PLATE 11. AMPHIROA ANCEPS (LAMK.) DECNE.

FIG. 1. Longitudinal section of geniculum, × 129.6; *2*, longitudinal section of geniculum and intergeniculum, × 129.6.

PLATE 12. BOSSEA PLUMOSA MANZA

FIG. 1. Habit of tetrasporic articulated plant, × 1.4; *2*, enlarged portion of articulated plant, showing position of conceptacles, × 26.6.

PLATE 13. BOSSEA CORYMBIFERA MANZA

Habit of tetrasporic articulated plants, × 1.

PLATE 14. BOSSEA FRONDIFERA MANZA

Habit of tetrasporic articulated plants, × 1.

PLATE 15. BOSSEA GARDNERI MANZA

Habit of tetrasporic articulated plant, × 0.7.

PLATE 16. BOSSEA INTERRUPTA MANZA

Habit of tetrasporic articulated plants, × 1.

PLATE 17. BOSSEA DICHOTOMA MANZA

Habit of tetrasporic articulated plant, × 1.

PLATE 18. PACHYARTHRON CRETACEUM MANZA

Habit of tetrasporic articulated plant, × 2.5.

PLATE 19. METAGONIOLITHON CHAROIDES WEBER VAN-BOSSE

Habit of tetrasporic plant, × 4.

PLATE 20. METAGONIOLITHON STELLIGERA WEBER VAN-BOSSE

FIG. 1. Longitudinal section of geniculum, × 150; *2*, longitudinal section of intergeniculum, × 79; *3*, enlarged portion of articulated frond showing mode of branching and caplike envelope at ends of branches, × 59.3.

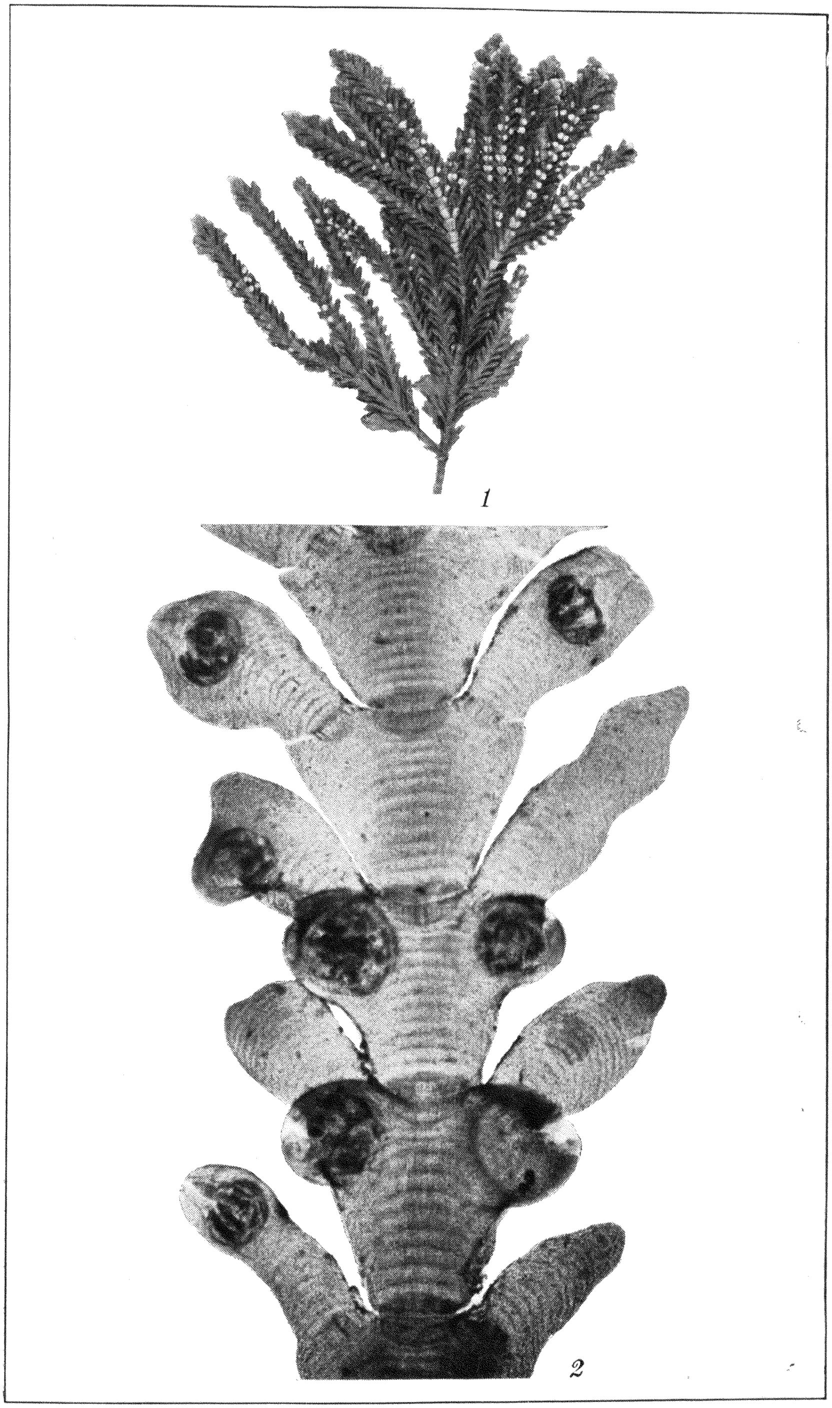


PLATE 1. JOCULATOR PINNATIFOLIUS MANZA.

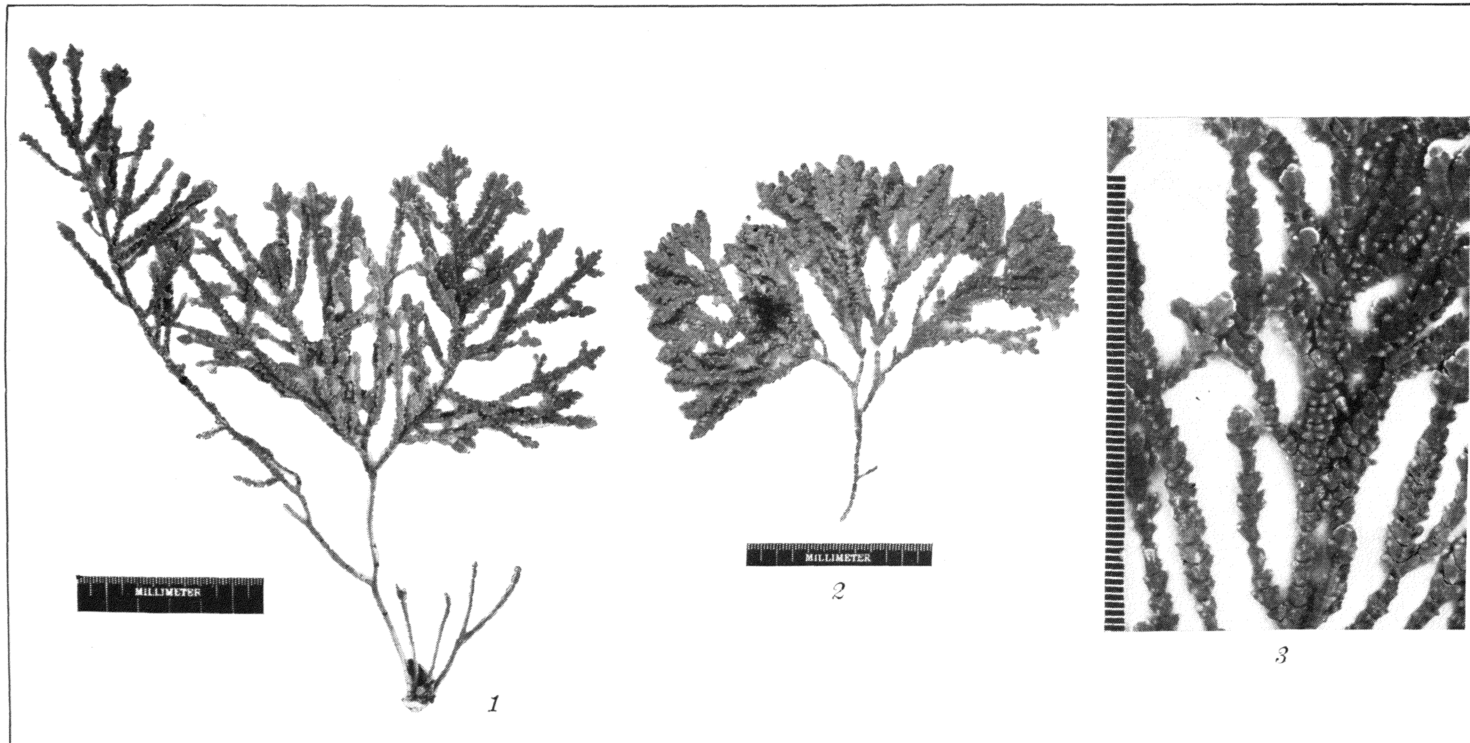


PLATE 2. CALLIARTHRON CHEILOSPORIOIDES MANZA.

PLATE 3. CALLIARTHRON PINNULATUM MANZA.

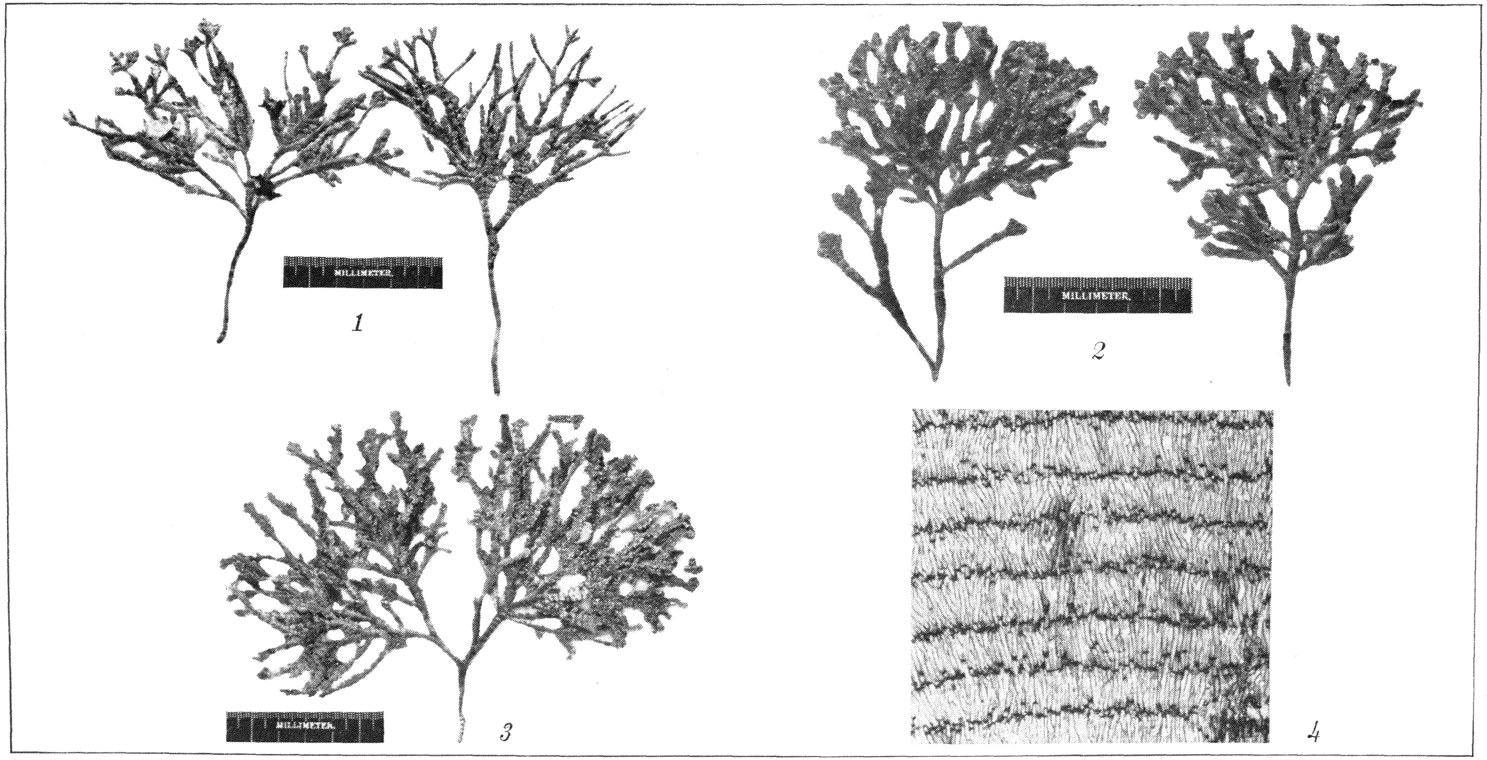


PLATE 4. CALLIARTHRON REGENERANS MANZA.

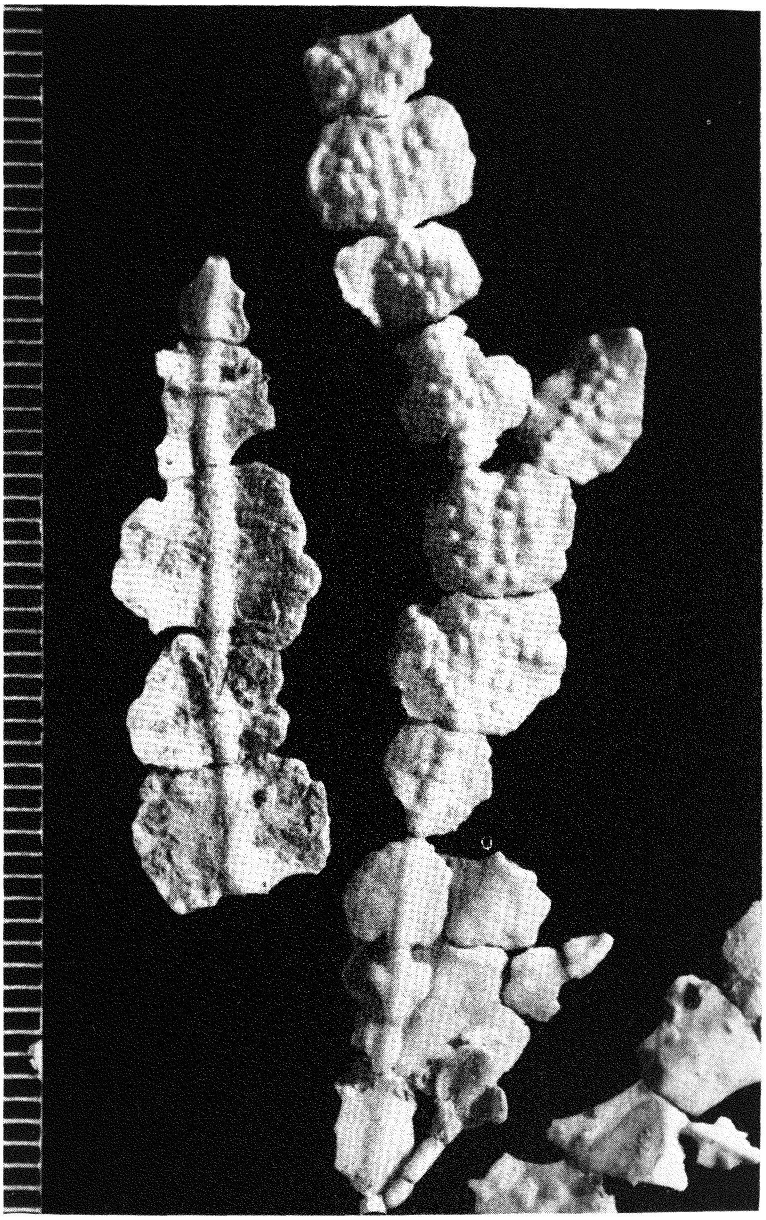


PLATE 5. CALLIARTHRON SCHMITTII MANZA.

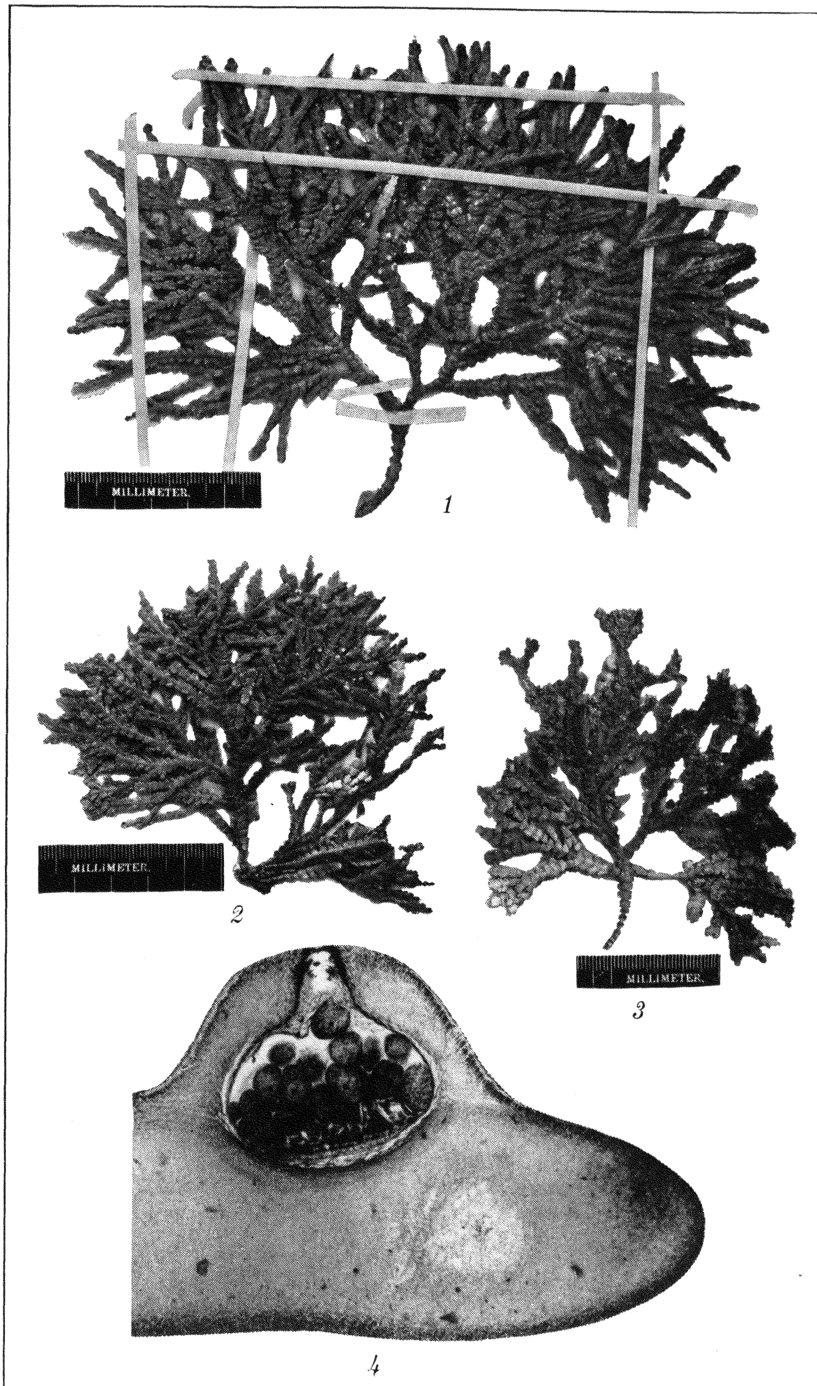


PLATE 6. CALLIARTHRON SETCHELLIAE MANZA.

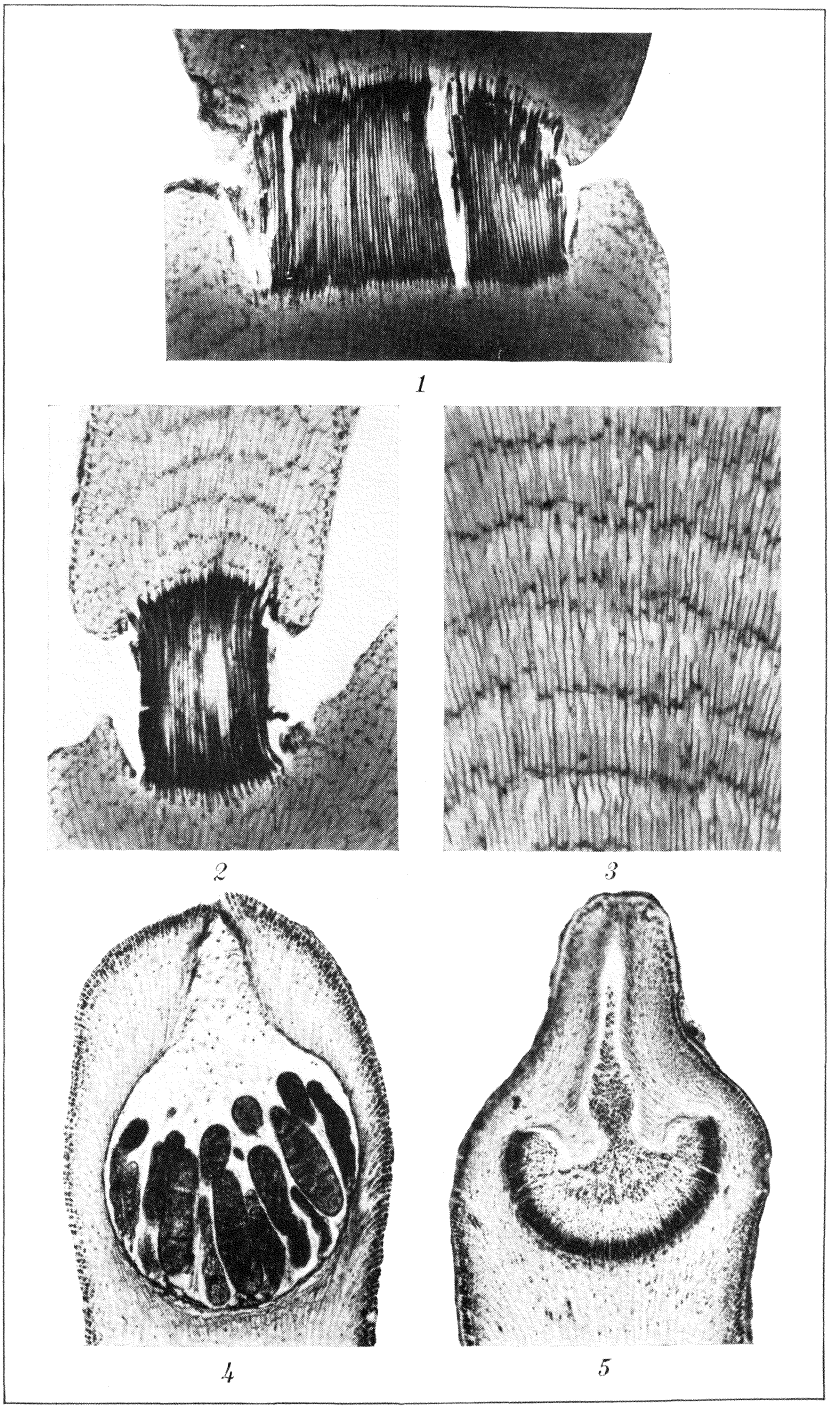


PLATE 7. CORALLINA (EUCORALLINA) OFFICINALIS LINNÆUS.

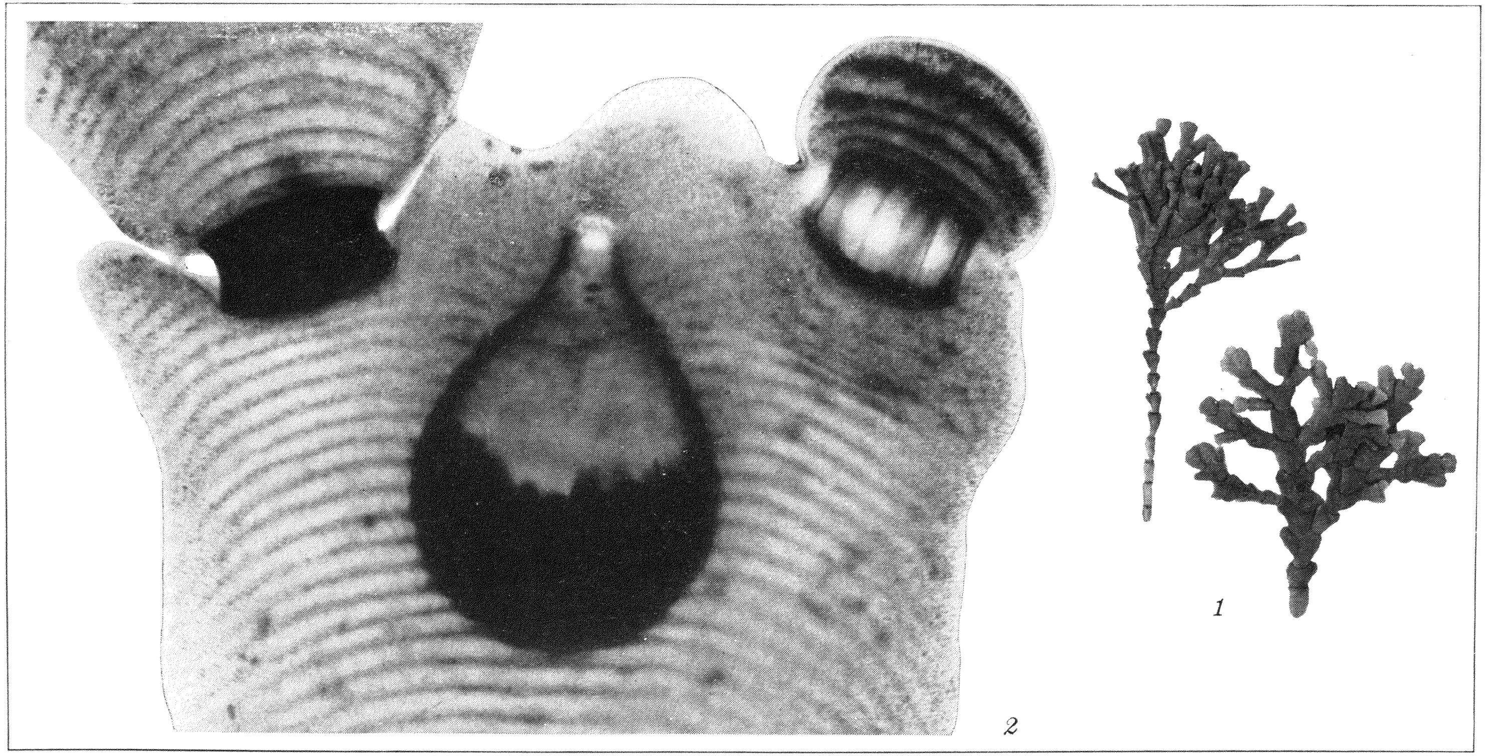


PLATE 8. DUTHIEA SETCHELLII MANZA.

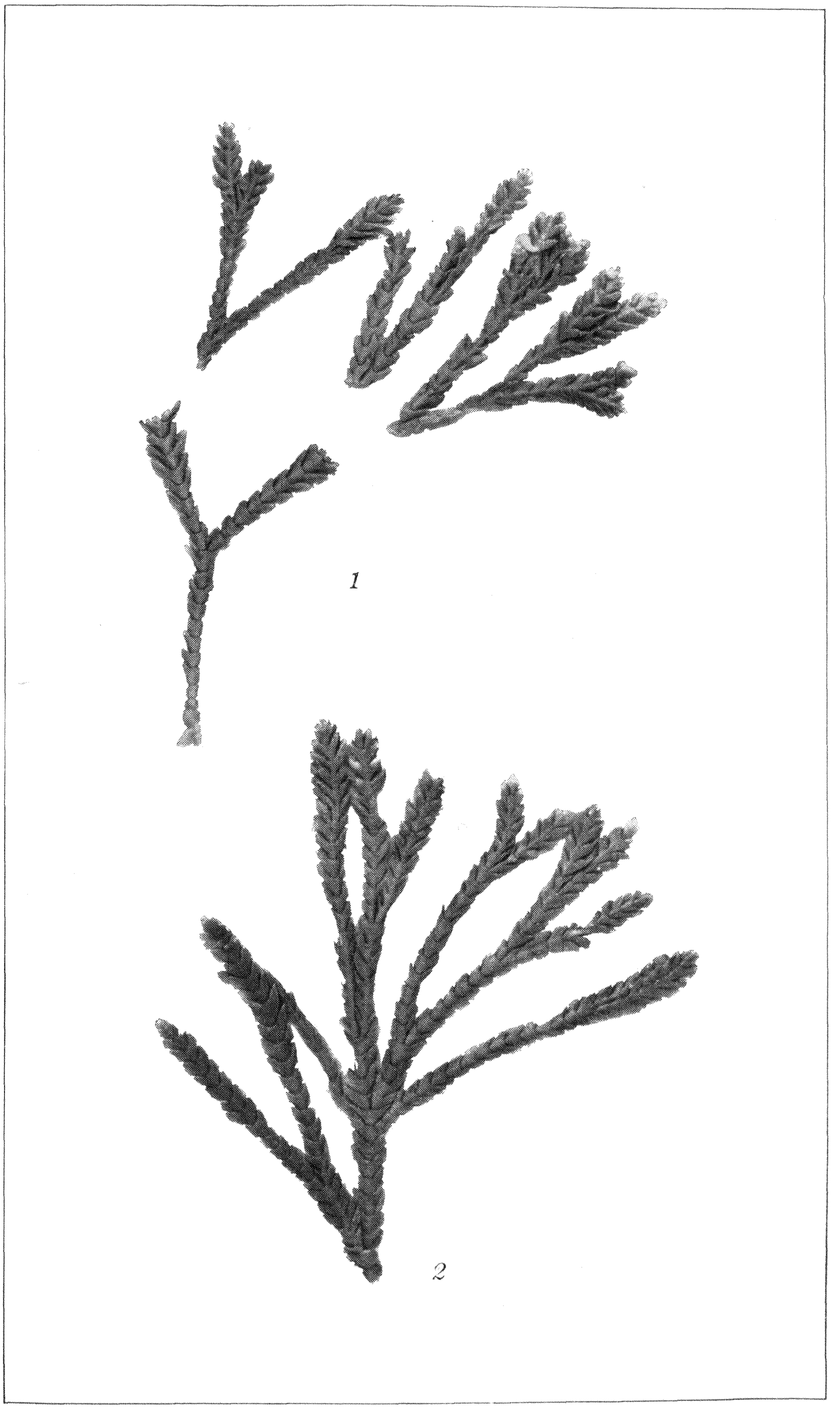
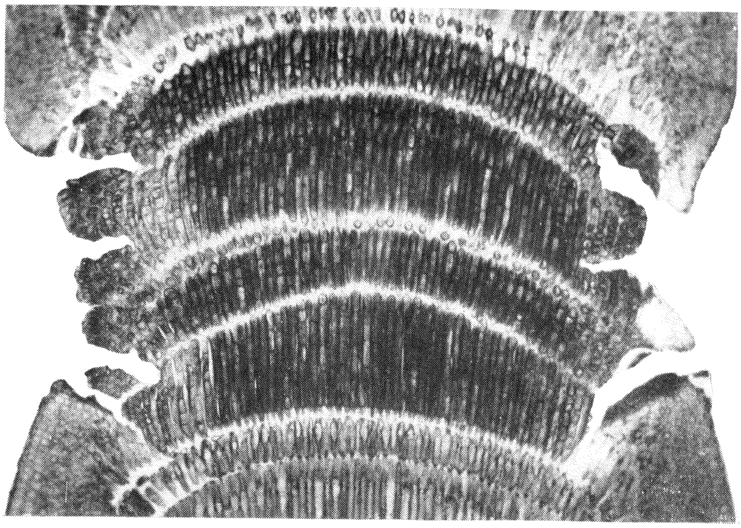


PLATE 9. CHEILOSPORUM SAGITTATUM (LAMX.) ARESCHOUG.

PLATE 10. LITHOTHRIX ASPERGILLUM GRAY.



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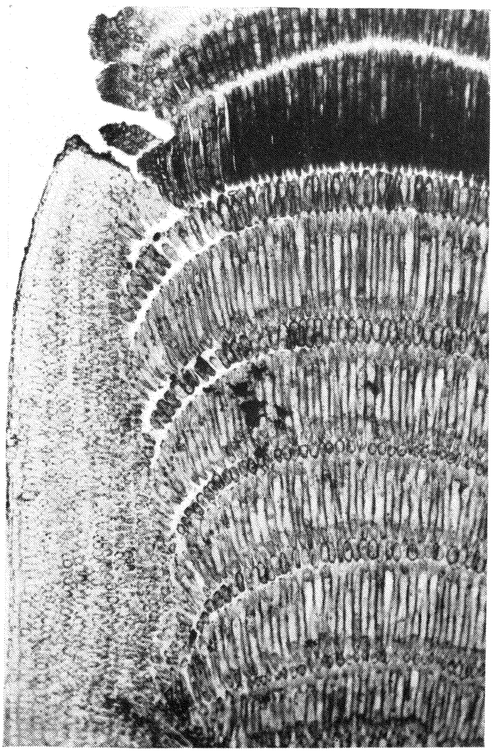

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PLATE 11. AMPHIROA ANCEPS (LAMX.) DECNE.

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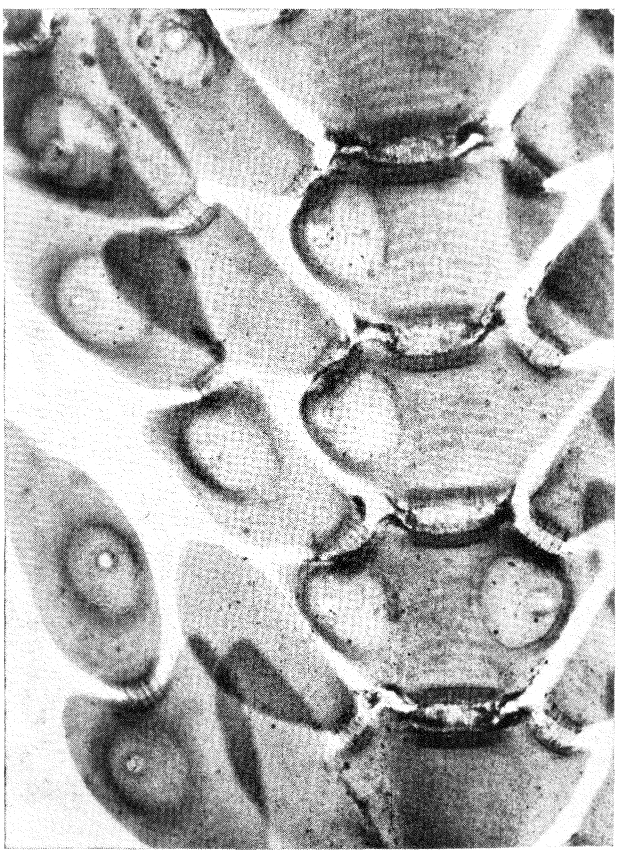

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PLATE 12. BOSSEA PLUMOSA MANZA.

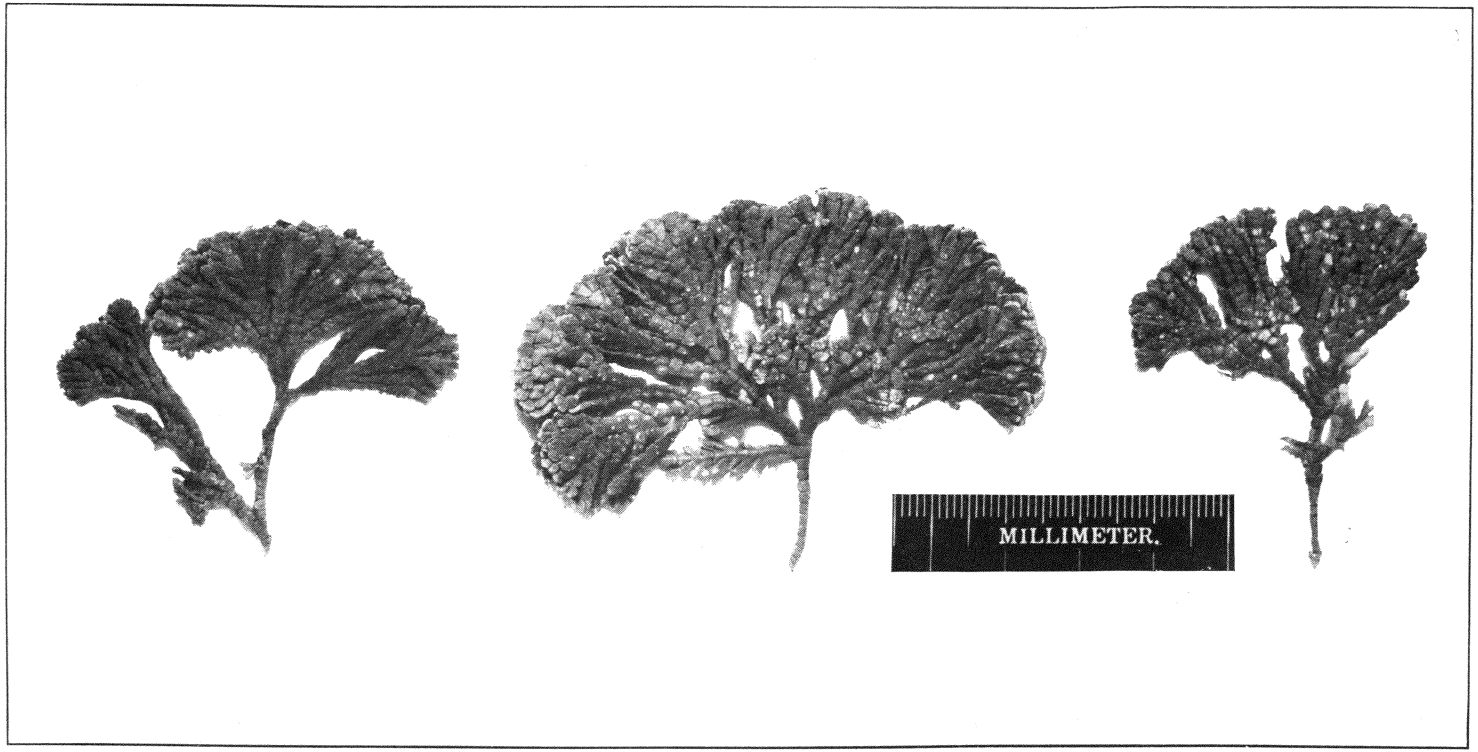

PLATE 13. BOSSEA CORYMBIFERA MANZA.

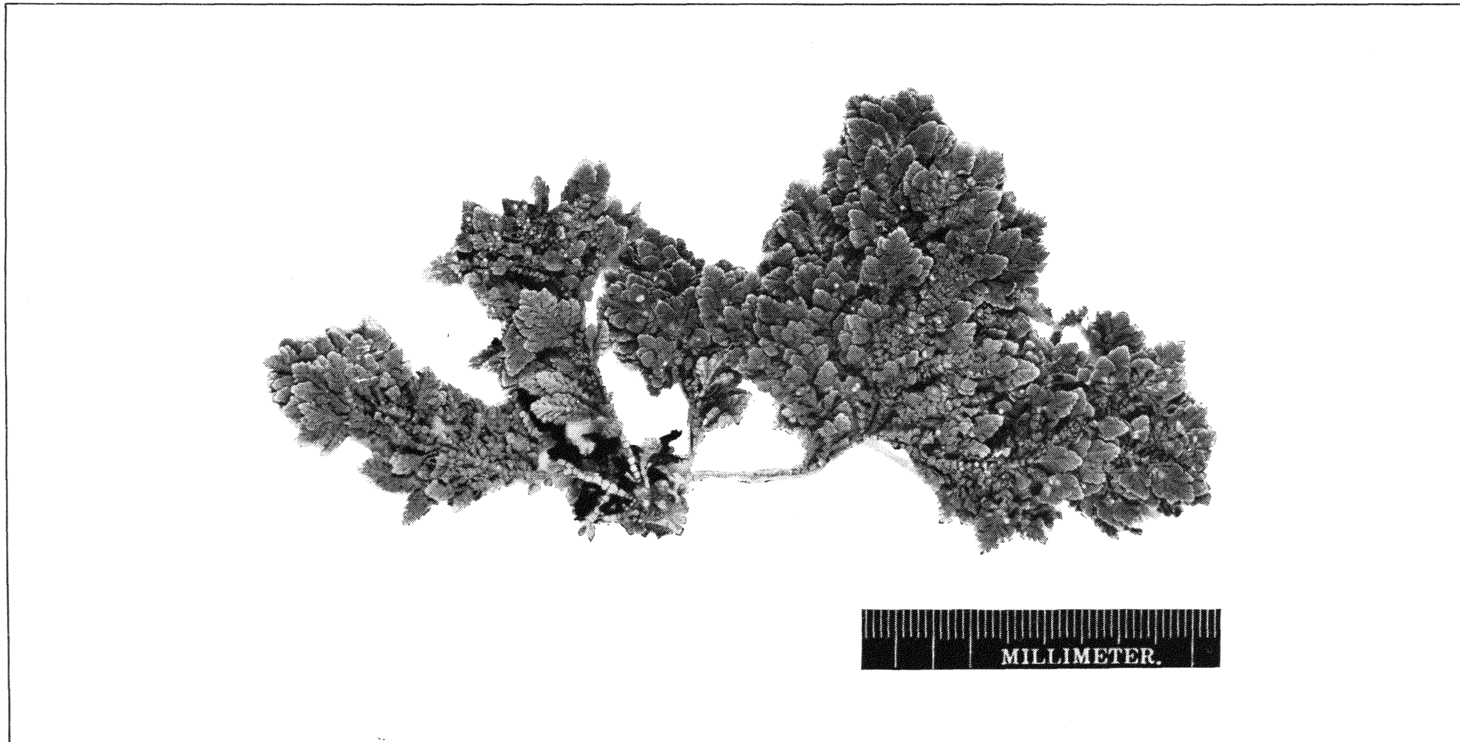

PLATE 14. BOSSEA FRONDIFERA MANZA.

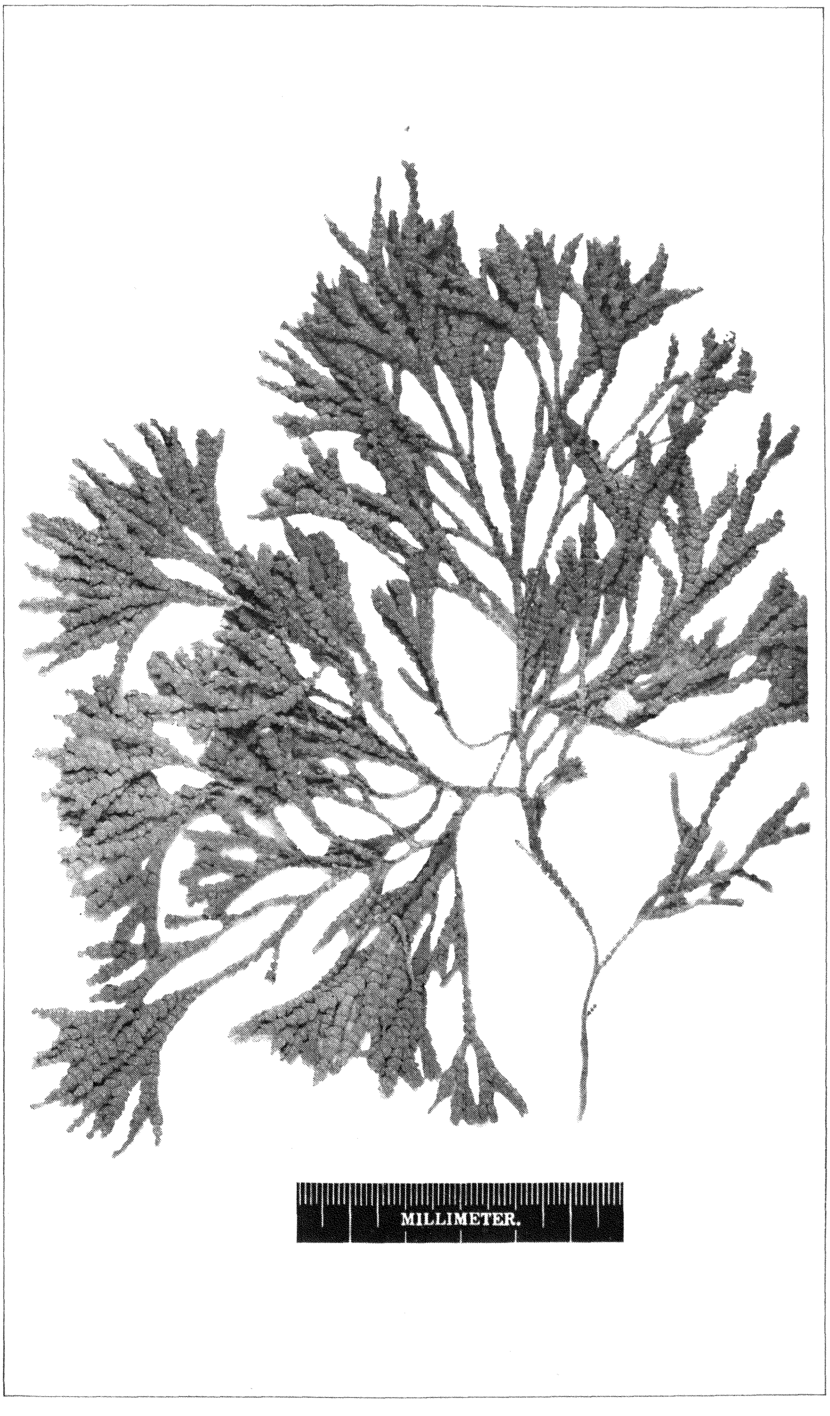

PLATE 15. BOSSEA GARDNERI MANZA.

PLATE 16. BOSSEA INTERRUPTA MANZA.

PLATE 17. BOSSEA DICHOTOMA MANZA.

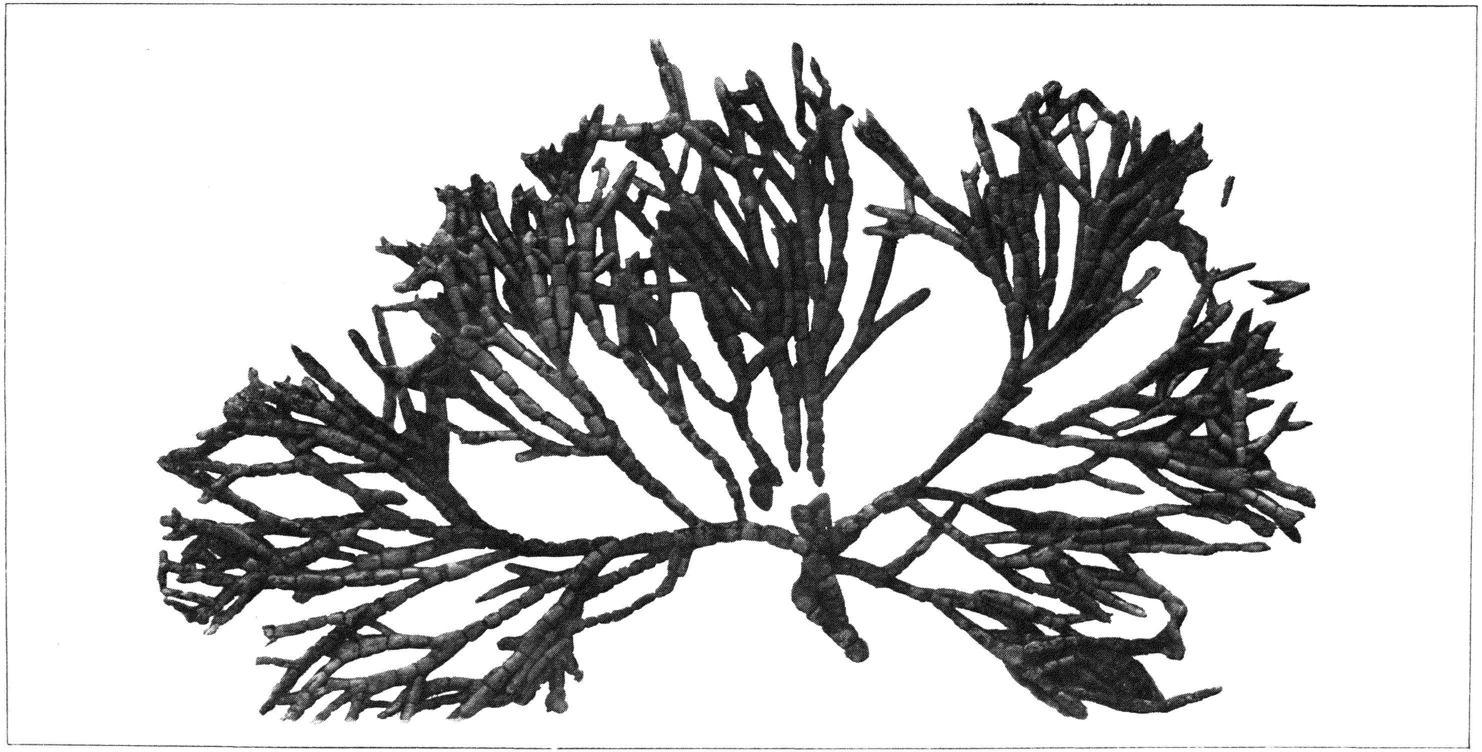

PLATE 18. PACHYARTHRON CRETACEUM MANZA.

PLATE 19. METAGONIOLITHON CHAROIDES WEBER VAN-BOSSE.

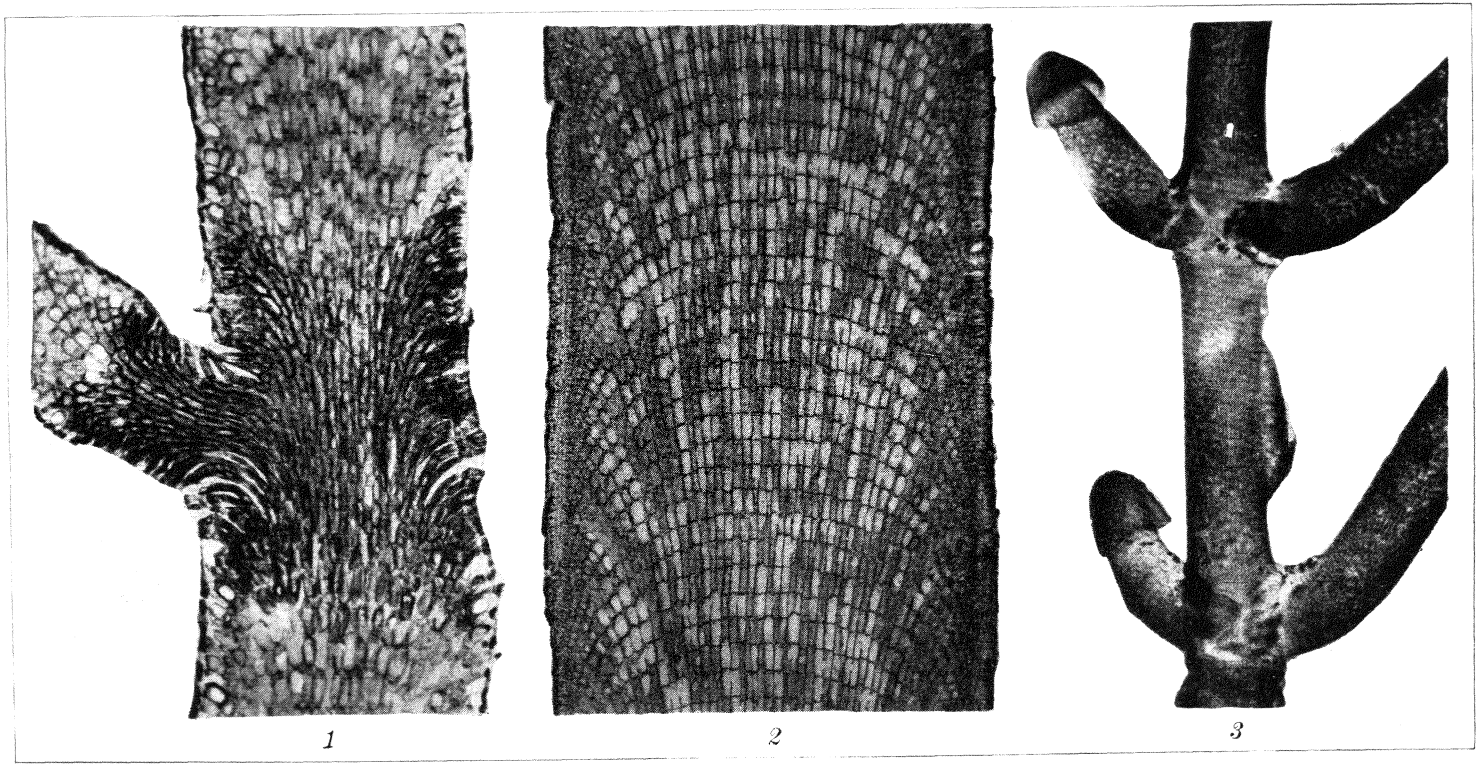

PLATE 20. METAGONIOLITHON STELLIGERA WEBER VAN-BOSSE.

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A CONTRIBUTION TO THE CHEMICAL STUDY OF THE BLOOD OF PHILIPPINE CARABAOS

By ARCADIO C. GONZAGA

Of the College of Veterinary Science, University of the Philippines, Manila

Data on the physiology of the Philippine carabao (*Bubalus bubalis* L.) are very meager, especially those relating to its blood chemistry. A survey of the literature has shown that, so far, the only available report on some blood constituents of this animal is that of Posa,(8) who made observations on five males and five females.

The purpose of the present article is to contribute more data on the physiology of the blood of the Philippine carabao.

MATERIALS AND METHODS

The observations were made on twenty carabaos, fourteen males and six females, 4 to 9 years old, and, as far as could be ascertained, free from disease.

The blood samples were drawn from the jugular vein and collected in clean vials. Where uncoagulated whole blood was needed, potassium oxalate was used as anticoagulant; where serum was necessary, the blood was allowed to coagulate and the serum separated from the clot after twenty-four hours, centrifuged to remove suspended debris, and kept in a refrigerator until used. Blood filtrates prepared according to Folin's unlaked blood method(3) were used in the determination of blood sugar, total nonprotein nitrogen, urea nitrogen, and chlorides. When not in use the filtrates were kept at refrigerator temperature.

The blood sugar was determined according to the colorimetric copper reduction method of Folin;(2) the total nonprotein nitro-

TABLE 1.—*Constituents of the blood of carabaos.*

Animals.			Milligrams per 100 cc of blood.								
Number.	Sex.	Age.	Sugar.	Total non-protein nitrogen.	Urea nitrogen.	Calcium.	Inorganic phos-phates.	Chlorides as NaCl.	Iron.	Hæmo-globin.	Oxygen.
		Years.								*g per cent.*	*Vol. p. c.*
1	F	9	40.16	18.80	21.80	10.50	7.35	446.00	51.81	15.47	20.72
2	M	8	49.51	25.67	15.72	10.00	3.90	485.00	46.51	13.88	18.60
3	M	6	55.25	25.35	13.50	10.50	4.85	490.00	48.54	14.49	19.42
4	M	5	39.22	28.78	12.44	9.50	4.35	455.00	42.19	12.59	16.88
5	M	5½	39.84	22.11	15.63	10.00	4.10	480.00	50.76	15.15	20.30
6	M	6	45.87	24.63	14.49	9.50	4.15	495.00	51.28	15.31	20.51
7	M	7½	44.45	20.42	13.78	9.50	6.45	465.00	48.08	14.35	19.23
8	F	8	41.32	18.95	18.12	10.50	4.55	479.00	51.55	15.39	20.62
9	M	4	46.30	20.63	15.70	10.50	4.18	470.00	41.49	12.39	16.60
10	F	5	44.84	19.29	14.52	10.00	5.66	456.00	42.55	12.70	17.02
11	M	4½	40.98	18.72	12.56	10.50	6.95	495.00	40.16	11.99	16.06
12	M	8	41.84	20.11	16.75	9.50	7.15	486.00	41.67	12.44	16.67
13	M	7½	41.49	19.15	12.98	10.00	5.95	478.00	44.84	13.39	17.93
14	F	5½	50.25	22.65	15.11	9.50	7.89	490.00	42.02	12.54	16.81
15	M	5	44.64	18.46	12.67	10.00	4.95	490.00	49.26	14.70	19.70
16	M	4	46.30	19.08	17.34	10.50	7.15	485.00	45.87	13.69	18.35
17	F	4½	40.32	18.14	15.31	10.00	6.37	495.00	51.28	15.31	20.51
18	F	6	41.15	22.39	14.23	9.50	4.95	455.00	40.32	12.04	16.13
19	M	6	39.68	20.04	13.38	10.50	6.65	495.00	50.51	15.08	20.20
20	M	5½	46.51	21.16	17.80	10.50	8.00	475.00	41.15	12.28	16.46
Average			44.00	21.23	15.19	10.05	5.78	478.25	46.09	13.76	18.44
Minimum			39.22	18.14	12.44	9.50	3.90	446.00	40.16	11.99	16.06
Maximum			55.25	28.78	21.80	10.50	8.00	495.00	51.81	15.47	20.72
Average, males			44.42	21.74	12.80	10.07	5.63	481.71	45.88	13.70	18.35
Average, females			43.01	20.04	16.52	10.00	6.13	470.17	46.59	13.91	18.64

gen, according to Folin and Wu;(4) the urea nitrogen, according to Karr's direct nesslerization method;(5) and the chlorides, expressed as sodium chloride, according to the method of Whitehorn.(9) The iron and hæmoglobin were determined from whole uncoagulated blood according to the procedure of Wong,(10) and the oxygen volume calculated(7) on the basis of the hæmoglobin content. The blood serum was used in the determination of calcium and inorganic phosphate (acid soluble). The calcium was determined according to the Clark-Collip modification(1) of the method of Kramer and Tisdall,(6) and the inorganic phosphate according to the procedure of Youngburg and Youngburg.(11)

RESULTS AND DISCUSSION

The results obtained in this study are given in Table 1.

The data obtained are about the same as those for cattle. In so far as the same constituents are concerned, they do not differ very much from those of Posa, with the exception of the values for the serum calcium and blood sugar, where striking differences were noted. In the present work the serum calcium ranges from 9.5 to 10.5 mg per cent, with an average of 10.05 mg, and the blood sugar has an average of 44.00 mg per cent, while Posa gives a range of 26.57 to 33.44 mg per cent, with an average of 28.19 mg for serum calcium, and 73.65 mg per cent for blood sugar. The low blood sugar values in the present work may be due chiefly to the procedure(3) followed in preparing the filtrates, which leaves minimum amounts of reducing nonsugars.

SUMMARY

The results of quantitative chemical determinations of certain blood constituents of twenty normal Philippine carabaos are presented. These constituents, with their corresponding values as obtained in the present study, are shown in Table 2.

TABLE 2.—*Summary of blood constituents of carabaos.*

Constituents.		Minimum.	Maximum.	Average.
		Per cent.	*Per cent.*	*Per cent.*
Blood sugar	mg.	39.22	55.25	44.00
Total nonprotein nitrogen	mg.	18.14	28.78	21.23
Urea nitrogen	mg.	12.44	21.80	15.19
Serum calcium	mg.	9.50	10.50	10.05
Inorganic phosphate	mg.	3.90	8.00	5.78
Chlorides as NaCl	mg.	446.00	495.00	478.25
Iron	mg.	40.16	51.81	46.09
Hæmoglobin	g.	11.99	15.47	13.76
Oxygen	volume	16.06	20.72	18.44

ACKNOWLEDGMENTS

The writer acknowledges his indebtedness to Dr. A. K. Gomez, acting dean, College of Veterinary Science, for suggesting the subject, and to the late Dr. T. Topacio for the use of animals and facilities in the Veterinary Research Laboratory, Bureau of Animal Industry, Pandacan.

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HISTOPATHOLOGY OF EARLY LESIONS IN FOURTEEN CHILDREN OF LEPERS, I

ANALYSIS OF PREVIOUS SKIN BLEMISHES IN RELATION TO SITES OF BIOPSIES AND OTHER POSITIVE AND PROBABLE LESIONS

By J. O. Nolasco and C. B. Lara

Of the Culion Leper Colony, Bureau of Health, Philippines

THREE PLATES

Gomez, Avellana Basa, and Nicolas,(6) in their study on 308 Culion children, concluded that

> The skin is the most frequent recognizable site of early lesions of leprosy, and infection by this route is greatly favored, presumably because of the great prevalence of skin diseases among children which offer anatomical conditions favorable to the invasion of the lepra bacillus.

Gomez,(5) in a subsequent paper based on a study of the clinical histories of 100 adult lepers confined in the San Lazaro Hospital, Manila, and supplementing the work done on Culion children, amplified his previous conclusion and stated that an initial primary lesion in leprosy does not necessarily exist.

Rodriguez,(22) continuing the previous studies of Gomez et al. on Culion children, found a single cutaneous lesion, which he believed to be the initial lesion, in 75 per cent of the 59 children who had become definitely leprous, and observed 3 cases in which the enlarging macules started from scabies scars.

Neff(18) previously reported the case of a 14-month-old child with a leprotic papulondule which cleared up after seven months of treatment, presumably of intramuscular injections with moogrol.

Chiyuto,(1) in order to confirm a new orientation on leprosy studies as advocated by Manalang,(13, 14, 15) examined 45 biopsies from 40 children of lepers varying in age from 2½ to 20 years. He found perivascular round-cell infiltrations in 30 of them, and tuberculoid leprosy in 15. Of the 30 perivascular round-cell infiltrations, 25 were from hazy depigmented areas, 2 from depigmented macules, 2 from normal skin, and one from an anæsthetic area. Of the 15 showing tuberculoid changes, 7

were from pinkish macules, 3 from "gooseflesh" areas, 3 from pale pinkish areas with circinate borders, 1 from a coppery lesion, and 1 from a hazy depigmented area. In none of them were acid-fast bacilli demonstrated in smears from the biopsy, aside from suspicious acid-fast granules in 1 case, a pinkish macule. Apparently no search was made for the acid-fast bacillus in the tissues. In another paper(2) he mentioned having noted small, pinkish, irregular areas of papulelike formations (rather erythematous), with fine and shiny surface in 5 cases.

Lara and de Vera (9, 10) recently reported cases of very early leprosy in children, and pointed out the occurrence of an unrecognized characteristic leprotic papule which is usually positive for *Mycobacterium lepræ*, occurring very early in infants of leprous parents.

Chiyuto in a third paper(3) noted similar lesions and suggested the name "intradermal nodule" for them. No smears were taken from the lesions of his cases, and in five that were biopsied it was stated that "the tissue reaction was similar to the nodule produced by positive leprolin reaction without pus formation." From this description the lesions were apparently tuberculoid. The five biopsies were said to be "negative for *M. lepræ* in tissue."

PRESENT STUDY

The present report is based on 14 biopsies of very early skin lesions of leprosy in 14 children of lepers, varying in age from 19½ months to 3 years and 4 months. The period of contact of these children with their leprous parents varied from 5 months and 12 days to 18 months. The biopsies were obtained from the 35 cases reported by one of us (C.B.L.) as having definite, or probable leprotic lesions of the skin,(8) determined by regular objective observations of the children at intervals of an average of two months or less from birth. Occasional bacteriological examinations for *M. lepræ* of the suspected leprous lesions by the "scraped-incision" method(28) were also made freely for confirmation. In the bacteriological examinations non-acid-fast bacilli, diphtheroids, and non-acid-fast coccoids and granules have apparently been observed and reported as either occurring alone or in association with acid-fast forms.[1] During the regular observations all skin blemishes, like disseminated, discrete, or

[1] Most of the bacteriological examinations were made by Dr. J. C. Manalang, of the Pathological Section.

closely set vesiculopapules with varying admixture of vesiculopustules, scabies, miliaria, mild ringworm, eczema, furuncles, wheals from insect bites, molluscum contagiosum, and so forth, were recorded, including a general regional or specific mention of their locations on the body surface. In this paper, besides the histopathological features observed in the biopsied material, an attempt was also made to analyze the individual protocols of the cases regarding the location of the previous skin blemishes in relation to the localization of the definite or probable leprotic biopsied lesion and other probable lesions, with the hope of gaining an insight into the probable genesis of these precocious lesions in very young children. These observations on previous skin blemishes are included in condensed form (under protocol) following the histological findings of each case.

The biopsies were all performed by Dr. J. G. Samson, in charge of the surgical work in Culion Colony. Only about half of the original lesion, if small, or a smaller portion of it, if larger, including some of the uninvolved skin was obtained, leaving a portion of the lesion for further clinical observations. In only one case (case 4) was the biopsy obtained from the center of the lesion, which was a hazy pale area 28 by 30 mm, with minute papules chiefly along the borders.

HISTOLOGICAL METHODS

The biopsied specimens were fixed in Zenker's fluid, and six micrasections made by the paraffin method. The sections were stained with eosin and hæmatoxylin, Voerhoff's stain for elastic tissues, Mallory's aniline-blue connective-tissue stain, and for acid-fast bacilli by means of a modification of Wade's method,(29) 5 per cent nitric acid being used instead of 15 per cent in the decolorization, and 1 to 3 dilutions of Loeffler's methyline blue instead of the concentrated solution, as counterstain.

In the beginning some specimens were also stained with Mallory's eosin and methylene blue, with the object of determining the possible presence of non-acid-fast bacilli in the sections, occasionally reported from the smears; but this procedure was later given up, since no apparent difference was found between this stain and the acid-fast stain in demonstrating the non-acid-fast structures. Mallory's aniline-blue stain for connective tissue was used primarily for the identification and examination of the nerves in the tuberculoid lesions as suggested by Wade.(26) Voerhoff's stain for elastic tissue was used for the identification

of the possible presence of scars in the specimens by the absence or scarcity of elastic elements in healed scars. Because of the very minute size of the lesions the entire specimens of all the cases were examined by sectioning serially the entire paraffin block and mounting the sections serially on numbered slides averaging from three to seven sections to a slide. Every 1st, 10th, 20th, 30th, and 40th or 50th slide of the series, as the case may be, was stained with eosin and hæmatoxylin; every 2d, 11th, 21st, 31st, and 41st or 51st slide was stained for elastic tissue; and every 3d, 12th, 22d, 32d, and 42d or 52d slide for connective tissue. By using these stained sections as a guide in locating the level of the serial sections where the amount of involvement of the corium by the leprous infiltration was most prominent, the slides to be stained for acid-fasts were then selected.

As control for the elastic tissue stain, a scar from the hand of a necropsied child (A.–1657), 8 months old, was used.

Search for non-acid-fast bacilli, non-acid-fast diphtheroids, coccoids, and granules was also made in the tissues of the first eight cases where they had been found. To control this part of the study biopsied skin from an adult nonleper previously infiltrated for 7½ months with iodized ethyl esters of *Hydnocarpus wightiana* oil,(20) and normal skin from the same nonleper, were used. The locally treated control nonleprotic skin sections showed lesions histologically simulating leprosy, due to the accumulation of large numbers of vacuolated monocytes attracted by the injected oil. In this control section non-acid-fast bacilli and beaded bacillary forms, and non-acid-fast granules and coccoids were also found. None of these were found in the normal skin control. As this control was considered not adequate, the skin having been injected with oil, another skin control section on file in our laboratory, a tertiary tubercular syphilide lesion, also showing a tuberculoid histology with very few spirochætes in the sections, was studied. In this section a few non-acid-fast, faint-staining bacillary forms and a few disintegrating nuclei whose chromatin contents showed clumps of faint-staining fragmented bacillary forms were also found. Because of these findings the search for non-acid-fast bacilli and non-acid-fast coccoids in the tissues had to be given up, as it was not possible to determine their exact nature. Since this point is not the main object of this paper it should be subjected to further investigation. As far as the present observations

go, these non-acid-fast, faint-staining bacillary forms and coccoids are interpreted as probably degenerated chromatin material of the numerous cells crowded in the lesions.

The search for acid-fast bacilli was most time consuming, as these bacilli were very scanty in the tuberculoid lesions. When no bacilli were found on the first attempt, several other preparations were examined. In all instances where acid-fast bacilli were found Doctor Wade, or Dr. J. Manalang, was consulted and requested to check the positive findings.

REPORT OF CASES

Biopsied lesions and histological findings; abstract of protocols of previous skin blemishes in relation to sites of biopsy and other probable leprotic lesions.

CASE 1; JOS. LUN., 2 years and 4 months. Thigh, left external, lower. First noted March 20, 1938, as a 1-cm or smaller, roughly rounded, pale-pink, rough, thickened area. Eight days later, on the day of biopsy, it was a deep-pink, thickened, hypopigmented, slightly granular area, 7 mm in diameter. Incised for smear taking only on day of biopsy; negative.

Histological.—Sections show a thin continuous layer of tuberculoid and epithelioid lesions superficially located, close to the epidermis, in contact at one end with the germinal epithelium where the germinal cells appear frayed at their bases. A few monocytes invade the germinal epithelium where it is in contact with the lesion. Lesions are richly supplied with capillaries. Intermediate and deeper layers of the corium show small and medium-sized foci and long strands of tuberculoids with a few Langhans's giant cells. Some of the smaller lesions appear isolated, the larger ones around small blood vessels. The long strands of tuberculoid lesions are in close relation and adjacent to one side only of two hairshafts, the lesions extending to the subcutaneous fatty tissue surrounding groups of sweat glands. Smooth hair muscles of two hairshafts are split and invaded by the tuberculoid lesion. The two hairshafts appear normal. Small perineural foci in the reticular layer close to the subcutis are also present, but the small nerve trunks are apparently not invaded aside from encroachment on their outer sheaths. Serial sections, however (slides 7 and 8), show in one nerve trunk actual invasion by two monocytes. This condition is found only at one level and not uniform in the course of the nerve. Round-cell collections are not a prominent feature, except slightly in the tuberculoid areas. Elastic fibers are present close to the basement membrane, in spite of the superficially located lesions very close to it and touching the epidermis at one point. No scar was found. One acid-fast bacillus was found in the lesion very near the surface (slide 7, section 1).

Protocol.—Born November 14, 1935. Separated from parents at 16 months.

Found positive (+) for *M. lepræ* from a papule in front left angle of mandible, June 29, 1938, three months after the biopsy of the left thigh lesion.

Previous skin blemishes and relation to probable lesions:

(C)[2] December 18, 1935. A few pin-head to pea-sized reddish vesicopapules over left of chest, left shoulder, right scapula, both sides of neck, and anterior of left thigh.

(C) February 15, 1936. Vesicopapular eruptions on cheeks, forehead, externally on upper abdomen, and feet. Fading scars on back.

(C) April 4, 1936. A number of drying scabieslike lesions and scars at dorsum of both feet, ankles, and legs. Numerous pale and brownish scars on trunk, arms, and forearms.

(C) September 23, 1936. Isolated papulovesicular eruptions, back of neck, left of chest, and left knee.

(C) February 2, 1937. Fairly numerous small, pale scars on trunk and upper extremities. Dry scabies lesion below right knee.

Separated from parents March 15, 1937, at 16 months.

(N)[3] *March 28, 1938; probable lesions:*

(*a*) Posteriorly on middle of right thigh, elevated, slightly hypopigmented area, 5 mm in diameter.

(*b*) Anterolaterally on upper right thigh, minute, hypopigmented, slightly raised area, about 1 mm in diameter.

(*c*) Similar lesion, posteriorly on right leg, 1.5 mm in diameter.

(*d*) Externally on left thigh, one on upper portion and one on lower portion, are two deep pink, thickened, hypopigmented, slightly granular areas, the upper 6 mm and the lower 7 mm in diameter, the latter biopsied on this date.

(*e*) On left lower lumbar a pink, slightly elevated, hypopigmented area, about 4 mm.

June 29, 1938.—Found positive (+)[4] for acid-fast facilli, from a papule 2.5 mm in front of left angle mandible, noticed 6 days before and 3 months after biopsy of left thigh lesion. The papule was flat, brownish red, firm, slightly shiny, apparently slightly inflamed at the margin but without distinct areola.

Comment.—Previous skin blemishes were pin-head to pea-sized vesicopapules, anteriorly on left thigh in December, 1935; vesicopapular eruptions on cheeks in February, 1936, scabieslike lesions and scars on legs in April, 1936, and numerous scars on trunk since April, 1936. No previous blemishes were noted in the right thigh.

CASE 2. MOI. MIÑ., 2 years and 6½ months. Posteriorly on upper right thigh. First noted as a hazy pale area about 1 cm in diameter, December 3, 1937; became 4.5 by 5 cm, but not very distinct, February 4, 1938. Two weeks after the latter date it measured 7 by 3 mm. March 8 it became a

[2] (C) indicates observations made in the Colony while the children were with their leprous parents.

[3] (N) indicates observations in the Nursery, after separation of the children from their parents.

[4] The following scheme has been followed in grading the smears for *M. lepræ:* ++++, globi in practically every field; +++, one to five globi in the whole smear, and bacilli in every field; ++, no globi but bacilli quite easily found, 6 to 20 in a field; +, no globi but bacilli found with difficulty. 1 to 5 in a field.

minute depigmented area, slightly shiny, not perceptibly elevated, 5 by 3 mm, and March 28 it was a hypopigmented, pink, slightly raised area about 5 by 4 mm, when it was biopsied. Incised for smear taking March 8 and March 28; negative for acid-fast bacilli in both instances.

Histological.—Sections show in the papillary layer six or seven small collections of large monocytes, almost side by side, showing very early epithelioid changes (Plate 1, fig. 1). They are superficially located close to the epidermis, a considerable portion of it in close contact with the germinal epithelium. From one of these collections a strand of round cells mixed with some monocytes with pink-staining cytoplasm and also showing in some cells beginning epithelioid changes (in serial sections) ensheathing a medium-sized blood vessel deeper in the section in close relation to a group of sweat glands and a minute nerve trunk (slides 8, 9, 10). The nerve trunk shows no apparent invasion of its sheath. Slight perivascular, round-cell collections are found on either side of the main lesion. A scar in the deeper serial sections (probably the incision of March 8 for smear taking) extends from deep down the corium to the surface. In the intermediate zone of the corium there is one minute collection of large monocytes and small round cells richly supplied with four capillaries. One or two cells in the collection show beginning epithelioid changes, while some are apparently undergoing mitosis. This small lesion is in relation to a small blood vessel and a duct of a sweat gland. No definite tuberculoid lesion was found. Hairshafts appear normal and uninvolved. The subcutis is also uninvolved. One giant cell is found in the depth of the scar, none in the monocyte collections. Two doubtful, short acid-fast rods (?) in a cell in the lesion (slide 16, section 3).

Protocol.—Born September 4, 1935. Separated from parents at 16½ months. Never found positive for *M. lepræ* in smears up to the day of biopsy.

Previous skin blemishes and relation to probable lesions:

(C) December 17, 1935. Fairly numerous reddish and brownish pinpoint to pin-head vesicopapules on abdomen, flanks, and chest.

(C) February 15, 1936. Ulcerated, large eruptions, probably scabies, on feet, hands, and back of head; a few scattered on trunk and other portions of extremities.

(C) April 3, 1936. Fairly numerous dark-brown scars on feet and lower legs.

(C) May 26, 1936. A few corn-sized superficial ulcers, presumably scabies, on dorsum of both feet. A few brown scars on both feet, around ankles, and on abdomen.

(C) September 22, 1936. A few reddish papular eruptions on feet, especially around ankles.

Separated from parents January 21, 1937, at 16½ months.

(N) October 1, 1937. Minute pale scars medially on right buttock and posteriorly on upper right thigh.

(N) December 3, 1937. Minute depigmented area, medially on right buttock and posteriorly on right thigh. Hazy pale area about 1 cm in diameter, posteriorly on upper right thigh.

(N) February 4, 1938. Small depigmented area just below right buttock, 3.2 mm in diameter, similar small area medially on right buttock.

Previous hazy pale area posteriorly on upper right thigh not very distinct, but apparently larger, 45 by 50 mm. On anteromedial upper right thigh a pale pinkish area, very slightly elevated, 3 by 4 mm.

(N) *March 28, 1938; probable lesions:*

(*a*) Hypopigmented, pink, slightly raised area, posteriorly on upper right thigh, 5 by 4 mm (biopsied).

(*b*) Similar lesion on middle of left buttock, about 2 mm.

(*c*) Minute depigmented spot, medially on right buttock, about 2.5 mm.

(*d*) Pink, indurated, distinctly elevated area, 6.5 by 3.5 mm, anteromedially on right thigh.

Comment.—Previous blemishes were a few ulcerated, large eruptions, probably scabies, scattered on extremities, in February, 1936; minute pale scars medially on right buttock and posteriorly on upper right thigh in October, 1937, which apparently became depigmented and hazy pale areas in December, 1937, and February, 1938; by March 28, 1938, these skin blemishes appeared as described above under that date (lesions *a* and *c*). No previous blemishes were noted in the left buttock.

CASE 3. BUE. MIA, 1 year and 8½ months. Leg, left, postmiddle. First noted March 7, 1938, as an indurated, thickened, brown, scarlike spot within an area of closely grouped scars. March 28, when it was biopsied, it was a dark, indurated scar, 11 mm in diameter. Incised for smear taking March 7 and March 28, 1938, negative for acid-fast bacilli in both instances.

Histological.—The section shows a small, definite scar from the depth of the corium to the epidermis, near one end of the section only, probably from smear taking March 7, 1938. The very superficial thin strip of corium beneath the epidermis through the length of the section, except a small portion at one end, shows evidence of superficial scarring by the complete absence of elastic fibers and the presence of many small blood vessels and numerous, fairly young, connective tissue cells. The epidermis shows uniform parakeratosis throughout. Immediately beneath this long and very thin strip of superficial scar, the papillary and reticular layers of almost the entire section, except at one end, appear cellular, due to a more or less extensive diffused distribution of round cells and large monocyte collections around blood vessels, two hairshafts, and sweat-gland ducts. No definite epithelioid or tuberculoid changes. Very small nerve trunks in the intermediate zone show no apparent changes. Serial sections show the same condition, except that the deepest coils of sweat glands near the subcutis are also involved. In one section close to a hairshaft very early evidence of apparent epithelioid changes is noted, and deeper down in the same section are three large collections of round cells and large monocytes in relation to coils of sweat glands. No definite tuberculoid lesion was found. Hairshafts show no changes. No giant cells. Probably a very young lesion about to become a tuberculoid. Two acid-fast bacilli found in a cell in the lesion (slide 3, section 1).

Protocol.—Born July 14, 1936. Separated from parents January 21, 1938, at 18 months. Up to the day of biopsy not found positive for *M. lepræ* in smears.

Previous skin blemishes and relation to probable lesions:

(C) August 5, 1937. Small, pea-sized, eroded vesico-papules, externally on thighs.

(C) October 2, 1937. Fresh scars with brownish background, rather extensive anteromedially and posteriorly on left leg and to a less extent anteriorly on right leg. A few pea-sized to bean-sized shallow ulcers at the same region. Fresh scabieslike lesions below right knee and externally on left cheek.

(C) December 4, 1937. Very extensive area of scar involving practically the whole left leg with a number of pea- to bean-sized superficial ulcers still present posteriorly and medially on left leg.

Separated from parents January 21, 1938, at 18 months.

(N) March 7, 1938. An indurated, thickened, brown, scarlike spot within an area of closely grouped scars posteriorly on middle of left leg.

(N) *March 28, 1938; probable lesion:*

Only one, posteromedially on left leg a dark, thickened, indurated scar, 11 mm in diameter (biopsied). No other suspicious lesions.

Comment.—Previous skin blemishes were extensive scars posteriorly on left leg and practically the whole left leg in October, 1937, and December, 1937; a thickened, indurated, brown, scarlike spot posteriorly on left leg, March 7, 1938, biopsied March 28, 1938. This lesion was definitely located beneath a scar, identified also histologically.

CASE 4. SUL. DIA., 1 year and 11 months at time of biopsy. Posterolaterally on upper right thigh. First noted February 4, 1938, as a pale area about 25 by 15 mm, slightly granular in the lower portion, suggesting follicular hypertrophy. Two weeks later the area had increased to 25 by 25 mm, with several pin-point to pin-head micropapules at the posteroinferior border, which were slightly reddish. March 28, 1938, this lesion measured 28 by 30 mm, still with minute papules chiefly along the borders. Biopsy March 29, taken from the center of the lesion. Incised for smear taking February 4, 1938, and March 28, 1938; negative for acid-fast bacilli in both instances.

Histological.—A very small scar near center of section, close to fresh incision of March 28, showing many dilated empty blood vessels. Scar relatively fibrous and cellular, embedding atrophic and regenerating hair-shafts probably injured in the first incision, February 4, 1938. Perivascular round-cell infiltration present, slight to moderate in superficial papillary layer of entire section. Smooth hair muscles with marked round-cell infiltration, splitting the muscle fibers (Plate 1, fig. 2); infiltrating cells mainly small, round cells and very few large monocytes. Deeper reticular layer clean, without lesions, except for some polynuclears infiltrating, apparently due to incision for smear taking, the day previous to biopsy. Intermediate zone of corium at one end showing slight perivascular round cells in relation to a smooth hair muscle, small nerve trunks, and a group of sweat-gland coils. Small nerve trunks and sweat glands in deeper corium uninvolved. No evidence of tuberculoid, or early epithelioid changes. Taken from center of hazy pale area with minute papules along borders. One acid-fast bacillus found in a round-cell collection (slide 11, section 1).

Protocol.—Born April 20, 1936. Separated from leprous parents at 13 months. Up to the day of biopsy not found positive for *M. lepræ* in smears.

Previous skin blemishes and relation to probable lesions:

(C) September 23, 1936. Moderate amount of papulovesicular eruption on arms, elbows, buttocks, and a few eruptions on hands and feet.

(C) December 4, 1936. A number of minute, closely-set, brown scars on trunk and extremities.

(C) February 2, 1937. Numerous minute, closely-set, brown scars on trunk and extremities; minute active scabies on both feet and ankles.

April 2, 1937. Dark-brown scars of scabies, both feet and lower legs. Thickened, scaling, fresh scars of scabies, anteriorly on left leg and above left heel. Pea-sized, eroded papulopustules, left posterior axillary fold, left elbow, and left buttock.

Separated from parents, May 15, 1937, at 13 months.

(N) August 4, 1937. A number of pin-head or smaller vesicopapules on hands, anteriorly on thighs and feet, and posteriorly on right thigh.

(N) December 3, 1937. A number of small dark-brown scars, scattered on trunk and extremities; no active skin eruptions.

(N) February 4, 1938. Posterolaterally on right thigh a pale area, about 25 by 15 mm, slightly granular on lower portion, suggesting follicular hypertrophy.

(N) *March 26, 1938; probable lesions:*

(*a*) Posterolaterally on right thigh a hazy pale area, about 28 by 30 mm in diameter, with minute papules chiefly along borders (biopsied).

(*b*) Posteriorly on upper left thigh a minute brownish-red papule, 3 mm in diameter, rather firm, apparently surrounded by a faint brownish halo.

Comment.—Previous skin blemishes were closely set scars on trunk and extremities, in December, 1936, and February, 1937; pin-head vesicopapules anteriorly on thighs and posteriorly on right thigh, August 4, 1937, and December 3, 1937; dark-brown scars scattered on trunk and extremities.

CASE 5. ROD. ABE., 1 year and 11½ months. Above left elbow. First noted February 26, 1938, as a pale pinkish, shiny, distinctly thickened area, 5 by 4 mm. March 31, 1938, this became distinctly hypopigmented, shiny, slightly pinkish, definitely thickened, 6 by 5 mm. Biopsied on this day. Incised only on day of biopsy for smear taking and found negative.

Histological.—Papillary layer of corium over a long stretch, showing 8 to 9 small epithelioid and tuberculoid foci side by side, in close contact with epidermis in places where many of the germinal cells show fraying of the basal cytoplasm and infiltration with occasional monocytes. (Plate 1, fig. 3). Papillary and reticular layers with fairly extensive sprinkling of tuberculoid and epithelioid foci in close relation with small blood vessels, ducts, and coils of sweat glands. In serial sections some of the subpapillary lesions evidently connected with some of the small superficially located papillary foci. Both borders of lesion apparently ending quite abruptly as smaller epithelioid lesions. No conspicuous round-cell collections on either margin. Round cells only slight to moderate in the epithelioid foci. No scar, elastic fibers present beneath epidermis in spite of the very superficially located lesions close to the germinal epithelium. Two small nerve trunks in the deep reticular layer (slides 15 and 25) surrounded and their fibers invaded and infiltrated by a tuberculoid lesion. A medium-sized nerve trunk in subcutis (slides 34 and 38) showing partial to complete tuberculoid infiltration of nerve fibers at different levels (Plate 2, figs. 5 and 6). This subcutaneous nerve in serial sections is a continuation of one of the infiltrated smaller trunks in the reticular layer. Two acid-fast bacilli in the deepest lesion (slide 4, section 2).

Protocol.—Born April 21, 1936. Separated from leprous parents at 13 months. Found positive (+) for *M. lepræ* in right knee, February 4, 1938, almost 2 months before the biopsy of left elbow lesion.

Previous skin blemishes and relation to probable lesions:

(C) September 23, 1936. Anterolaterally on right leg several minute papulovesicular eruptions, medially on side of right leg a large bluish erythematous area with thickened border.

(C) December 4, 1936. A number of pale-brown scars on upper back; a few pin-head, reddish vesicopapules on shoulders, anterior axillary folds, and above knees. Minute scaling on dorsum of both feet.

(C) February 2, 1937. Minute healing scabies on right big toe and external malleoli.

(C) April 2, 1937. A few small, fresh scars on feet and lower legs.

Separated from parents, May 22, 1937, at 13 months.

(N) August 4, 1937. Very hazy pale mottlings anteriorly on legs and anterolaterally on thighs.

(N) October 1, 1937. Anterolaterally legs practically normal.

(N) February 4, 1938. One inch below left popliteal a reddish, wheal-like, slightly shiny, raised area, about 5 mm in diameter. On upper part of left knee a small, pale, rather shiny, thickened area, apparently with subsiding central puncture, 5 mm by 3 mm. Medially on right knee a similar lesion, about 4 mm in diameter. The latter positive (+) for *M. lepræ.*

(C) February 26, 1938. Just above the left elbow a pale pinkish, shiny, distinctly thickened area, 5 by 4 mm, suspicious.

(C) *March 31, 1938; positive and probable lesions:*

(*a*) Previous lesion below left popliteal, still pinkish, distinctly thickened, 6 by 4 mm.

(*b*) Lesion above left elbow distinctly hypopigmented, shiny, slightly pinkish, definitely thickened, 6 by 5 mm (biopsied on this day).

(*c*) Lesion over upper left knee distinctly pinkish and thickened, slightly shiny, 5 by 4 mm.

(*d*) Previous positive lesion medially on right knee now a dark-brown scar, infected and scratched after smear taking, February 4, 1938.

(*e*) On upper right knee a slightly thickened area, not distinctly hypopigmented, 9 by 6 mm.

Comment.—Previous blemishes at sites of probable lesions were a few pin-head, reddish vesicopapules above knees, in December, 1936, and fresh scars on lower legs, April, 1937. No previous blemishes noted on left elbow.

CASE 6. ERN. VIB., 1 year and 9 months. Right thigh, upper, external. First noted February 4, 1938, as a pinkish, slightly shiny papule, about 3 mm in diameter, surrounded by a narrow pale halo. Positive (++) for *M. lepræ.* March 12, 1938, the lesion was still fairly distinct, 3 mm in diameter, pinkish, slightly wrinkled and surrounded by a pale halo when it was biopsied. Incised once for smear taking, February 4, 1938.

Histological.—In the papillary layer the section shows a very thin continuous layer of epithelioid and tuberculoid lesion (slides 2, 5, 7) for a length of about 1.5 mm in close contact in places with the germinal epithelium over which elastic tissue is absent for a length of about 1.2 mm.

The overlying epidermis for 2.3 mm is flattened over it. This possibly represents a portion of the incision scar of February 4, 1938. At about the middle of the papillary layer the lesion extends downward between two closely set hairshafts to the depth of the reticular layer, forming infiltration around small nerve trunks, smooth hair muscles, blood vessels, and a small group of sweat-gland coils in the deepest margin of the reticular layer. In the subpapillary and reticular layers on either side of the two hairshafts mentioned are small collections of epithelioids in relation to small blood vessels, and infiltrating smooth hair muscles. Deeper serial sections show larger epithelioid and tuberculoid lesions in the papillary and reticular layers, and a deep scar (incision February 4, 1938) near the border of the lesion. A small nerve trunk in the deeper corium shows invasion of the nerve fibers with large monocytes (slides 5, 6, 7). On either side of the lesion, where it joins the normal skin, the transition as smaller epithelioid lesions appears to be abrupt. Several acid-fast bacilli easily found in both superficial and deeper lesions (slide 4, section 1).

Protocol.—Born June 12, 1936. Separated from leprous parents at 13 months. Found positive (++) for *M. lepræ* from a papule externally on upper right thigh, February 4, 1938, a little over 1 month before its biopsy, March 12, 1938.

Previous skin blemishes and relation to probable lesions:

(C) December 8, 1936. A number of pin-head reddish wheals on cheeks; fairly numerous pin-head or larger dark-brown spots posteriorly on forearms, anteriorly on legs, externally on right thigh, probably subsiding wheals. Red wheal on right hip.

(C) February 2, 1937. On left side of chest a small, pea-sized, dark-brown, thickened scar.

(C) June 2, 1937. A few dark-brown scars on left side of chest and left buttock; dark-brown scars posteriorly on right thigh, right side of chest, medially on right arm.

Separated from parents, June 19, 1937, at 13 months.

(N) December 3, 1937. A number of dark-brown scars on legs, thighs, and buttocks.

(N) February 4, 1938. Minute reddish wheal on upper right cheek below malar and erythematous spot on middle of left cheek. On upper external right thigh, about 1 inch below, and a little posterior of major trochanter, a pinkish, slightly shiny papule about 3 mm in diameter, surrounded by a pale halo, slightly suspicious [positive (++) for *M. lepræ* on this date]. Returned to parents in the Colony, February 7, 1938.

(C) February 12, 1938. On middle of right cheek a pale pinkish, thickened area, 4 mm in diameter, with a very hazy pale halo.

(C) February 26, 1938. (*a*) A red, flat papule on right cheek, 4 mm in diameter. (*b*) A papule posterolaterally on upper right thigh, 4 mm in diameter, shiny, slightly wrinkled, deep pink. (*c*) Anteriorly on upper right forearm, a reddish, very slight elevated area, also 4 mm in diameter, surrounded by a very faint, pale halo.

(C) *March 12, 1938; positive and probable lesions:*

(*a*) On right cheek, quite thin, almost imperceptibly elevated, distinctly pinkish, 6 by 5 mm.

(*b*) Positive lesion, posterolaterally on upper right thigh, still fairly distinct, 3 mm in diameter, pinkish, surrounded by a pale halo (biopsied).

(*c*) Anteriorly on upper right forearm a brownish spot, about 3.5 mm in diameter, almost imperceptibly elevated, apparently subsiding, indurated.

Comment.—The previous blemishes mentioned were reddish wheals on cheeks, and fairly numerous pinkish, larger, dark-brown spots, posteriorly on forearms and externally on right thigh in December, 1936; dark-brown scars posteriorly on right thigh in June, 1937, and on thighs in December, 1937.

CASE 7. EPI. GAL., 1 year and 8 months. Posteromedially on right arm. First noted February 4, 1938, as a pin-head, shiny, pinkish papule, surrounded by a very pale, reddish zone, positive (+++) for *M. lepræ* on this date. Apparently not present in the last previous examination, December 3, 1937 (*see* protocol below). February 25 this pin-head papule was 3 mm in diameter, surrounded not by a red areola but by a narrow pale halo. March 12, when it was biopsied, it was 4 mm in diameter and distinctly thickened. Incised once for smear taking, February 4, 1938.

Histological.—Sections show for a stretch of about 3 mm in the papillary layer a continuous uninterrupted layer of epithelioid lesions of moderate thickness, in close contact with the epidermis in places where the basal cytoplasm of the germinal cells is frayed and invaded by a few monocytes. Elastic fibers beneath epidermis are absent for a stretch of 1 mm in the center of the involved papillary layer (slide 2), where three moderate-sized blood vessels are present side by side at this level close to the epidermis but within the epithelioid lesion. Epidermis flattened over scar, and for some distance on either side of it. This flattening possibly represents only a small portion, the border of the incision scar of February 4, 1938. In all the other serial sections examined there is no evidence of deep scarring. A strand of epithelioid lesion extends deeply into the subpapillary reticular layers, infiltrating a smooth hair muscle around a hair-shaft, sweat gland duct, and deep coils of the sweat-gland duct. Deeper sections show isolated small and medium-sized epithelioid and tuberculoid lesions. Small nerve trunks show perineural epithelioid collections, and in two the nerve sheaths are involved by the perineural epithelioid collections (slide 9). The lesion having been incised for smear taking February 4, the very superficial thin scar noted may represent only the edge of the incision scar included in the biopsy. Many acid-fast bacilli found (slide 7, section 2).

Protocol.—Born July 11, 1936. Separated from leprous parents at 16 months. Found positive (+++) for *M. lepræ* posteromedially on the right arm, February 4, 1938, at 1 year and 7½ months.

Previous skin blemishes and relation to probable lesions:

(C) September 24, 1936. Plenty of minute papular eruptions on upper eyelids, cheeks, especially on trunk, anteriorly and posteriorly, a few on extremities where minute dark scars are more distinct.

(C) December 7, 1936. No active skin eruptions, but a number of small dark-brown spots on back, either scars or traces of previous wheals.

(C) February 3, 1937. Pea-sized, subsiding, reddish, inflamed papule posteriorly on right leg. Raised reddish thickened scar on right elbow.

(C) April 3, 1937. A number of minute vesicopapules on both buttocks. Drying, bean-sized, crusted ulcers posteriorly on right leg.

(C) October 2, 1937. Fairly numerous fresh, thickened, dark-brown, small scars anteriorly on legs, especially on left knee and a few on feet, externally on thighs, ulnar side of wrists, and above coccyx.

Separated from parents November 23, 1937, at 16 months.

(N) December 3, 1937. Numerous pea- to bean-sized, slightly raised, drying, healing ulcers, probably scabitic, on feet, legs, thighs, both forearms, and on arms and buttocks. On buttocks fairly numerous dark-brown scars.

(N) February 4, 1938. Posteromedially on right arm a pin-head, shiny, pinkish papule, surrounded by a very pale reddish zone, distinctly suspicious. Positive (+++) for *M. lepræ*. Returned to parents in the Colony, February 7, 1938.

(C) February 12, 1938. Anterolaterally on right thigh about middle portion a pink shiny papule, 3 by 5 mm, surrounded by a faint, pale halo.

(C) February 25, 1938. Red shiny papule, 3 mm in diameter, posteromedially on right arm and 4 cm above elbow. Externally on lower right thigh, 5 cm above knee, another red papule, about 5 mm. Positive (++) for acid-fast bacilli.

(C) *March 12, 1938; positive and probable lesions:*

(*a*) Positive lesion, posteromedially on right arm, now a shiny pin-head papule, 4 mm in diameter, distinctly thickened (biopsied).

(*b*) Positive lesion anterolaterally on right thigh, now a purplish papule about 5 mm in diameter, surrounded by a narrow pale halo.

(*c*) On the lower left buttock a pinkish papule about 3 mm in diameter, slightly indurated, not surrounded by a pale halo.

Comment.—Previous blemishes were papular eruptions on extremities with minute dark scars, in September, 1936; vesicopapules on both buttocks in April, 1937; thickened dark-brown scars, externally on thighs in October, 1937; and healing ulcers, probably scabitic, on thighs, arms, and buttocks, with fairly numerous dark-brown scars on buttocks in December, 1937.

CASE 8. EDI. URO., 2 years and 8 months on date of biopsy. Anteromedially on left leg, two inches above ankle. First noted February 4, 1938, as a small papule, 3 mm in diameter, resembling a wheal, shiny, very slightly pinkish, surrounded not by a red areola but by a very faint, pale halo. February 19 it was 4 by 2 mm, surrounded by a hazy, pale halo 12 by 11 mm. March 8 it was 5 by 4 mm, pale pinkish, shiny, slightly elevated, surrounded by faintly hypopigmented skin, 10 mm in diameter. March 28 it was 5 by 6 mm, shiny, slightly elevated, very slightly hypopigmented, slightly indurated. Positive (+) for *M. lepræ* in smears on this date, when it was biopsied. Incised for smear taking February 4 and March 28, found positive only on latter date.

Histological.—Biopsied specimen thin, subcutaneous tissue not included. Sections show the lesions at one end traversed by a healed, deep scar, due to previous smear taking February 4, over which the epithelium is flattened. On either side of the scar in the papillary layer are epithelioid foci, side by side, fairly rich in capillaries which are congested. In deeper serial sections these superficially located lesions are in contact (slide 10) with the germinal epithelium, whose cells show fraying of their basal cytoplasm in places. Subpapillary and reticular layers on either side of scar dotted with epithelioid and tuberculoid lesions, some of lesions in subpapillary

layer appearing in serial sections as direct extensions from the more superficially located lesions. As in previous cases, the lesions are in relation tc hairshafts, small blood vessels, and sweat gland ducts. One small nerve shows a perineural tuberculoid lesion encroaching on its sheath. One acid-fast bacillus found in a large deep lesion (slide 1, section 1).

Protocol.—Born July 21, 1935. Separated from parents to relatives outside the Colony about the end of October, 1935, at 3 months. Returned to Colony Hospital with parents for colitis and pneumonia February 4, 1936, and separated again from leprous parents April 16, 1936, upon recovery at the hospital, at 9 months. Actual total period of exposure, 5 months and 12 days. Found positive in smears (+) for *M. lepræ*, March 28, 1938, anteromedially on left leg, the day of biopsy.

Previous skin blemishes and relation to probable lesions:

(C) April 3, 1936. Occasional reddish wheals on left leg and on right side of back.

Separated from parents for second time April 16, 1936, at the age of 9 months, after hospitalization for 2 months and 12 days.

(N) July 28, 1936. Minute healing vesicopapules on lower legs, and fresh pin-head to larger vesicopapules on lower back and both sides of chest and medially on arms and chest.

(N) September 21, 1936. Skin rough where there are papulo-vesicular eruptions at upper trunk, arms, legs, and ankles.

(N) December 3, 1936. Fresh scars medially on right foot. Groups of a few pin-point or pin-head vesicopapules, not congested on right flank, right infra-axillary, and left interscapular.

(N) February 1, 1937. Subsiding, scaling, minute vesicopapules on buttocks and around ankles.

(N) March 17, 1937. Several whitish pin-head papules at knees. Feet dry with several small vesicopustules.

(N) June 1, 1937. Patch of eczematoid dermatitis on ulnar side of left wrist and posteriorly on lower right leg. Group of small scars anteriorly on lower left leg.

(N) February 4, 1938. Anteromedially on left leg, 2 inches above ankle, a small papule, shiny, resembling a wheal, very slightly pinkish, 3 mm in diameter, suspicious. Smears taken on this day negative for acid-fast bacilli.

(N) February 19, 1938. Above lesion now 4 by 2 mm, surrounded by a hazy, pale halo, 12 by 11 mm.

(N) March 8, 1938. Above lesion, pale pinkish, shiny, slightly elevated. now 5 by 4 mm.

(N) *March 28, 1938; probable lesion:*

Only one, above lesion, anteromedially on left leg, shiny, slightly elevated, slightly indurated, very slightly hypopigmented, now 5 by 6 mm (biopsied). No other lesion. Positive (+) for only one acid-fast bacillus.

Comment.—Previous skin blemishes on left leg reddish wheals in April, 1936, healing vesicopapules in July, 1936; papulovesicular eruptions in September, 1936; and a group of small scars in June, 1937. Total period of exposure of this child was 5 months and 12 days.

CASE 9. ANA. MAN., 1 year and 7½ months on date of biopsy. Above right knee. First noted February 4, 1938, as a pale pinkish area, about

7 by 5 mm, very slightly raised. March 8, 1938, it was still fairly distinct as a faint, light-purplish, elevated area, 10 by 5 mm, with the center more deeply purplish and showing a linear scar due to incision for smear taking February 4, the whole area very slightly hypopigmented. March 28, the day of biopsy, it was 12 by 5 mm, hypopigmented, slightly pinkish, slightly elevated, with depressed, deep-pink, shiny center, site of previous smear taking. Incisions for smears February 4, March 9, and March 28, 1938, all negative for acid-fast bacilli. The remaining lesion left in the child for further clinical observation became positive (+) June 4, 1938, a little over 2 months after biopsy.

Histological.—Sections show a small scar (incisions of February 4 and March 9) in the center of the lesion, extending from about the middle of the corium to the epidermis. Below the scar and on either side of it, around blood vessels and hairshafts, are small and medium-sized epithelioid and tuberculoid lesions, with infiltration of the smooth hair muscles, sweat glands and ducts, and small nerve trunks. In the papillary layer are three or more small epithelioid foci and slight pervicascular infiltrations, one of the epithelioid foci in close contact with germinal epithelium, producing fraying of basal cytoplasm of their cells. This point is close to the incision scar mentioned above (slide 7). Deeper sections (slide 15) show two other, very small epithelioid foci similarly in contact with the germinal epithelium. Some of the small nerve trunks in the lesions, although appearing as still intact except for their obscure epineural sheath, show in the serial sections definite epithelioid invasion in spots of their epineural sheath, where one or two monocytes (Plate 2, fig. 7) may be seen in the nerve trunks within the capsule (slides 6, 7, and 8). In the aniline-blue sections a small nerve in the deep corium shows definite invasion of the nerve trunk when traced in serial sections (slides 6, 7, and 8, serial), and the delicate wavy-blue-staining connective tissue appears dispersed and frayed by the cellular infiltration. Several acid-fast bacilli found in superficial and deep lesions (slide 4, section 1).

Protocol.—Born August 14, 1936. Separated from parents at 17 months.

Previous skin blemishes and relation to probable lesions:

(C) June 2, 1937. A number of minute healing vesicopapules on dorsum of feet and on left ankle.

(C) August 6, 1937. A few minute brown scars on feet and lower legs.

(C) October 2, 1937. A few minute pale scars on buttocks and brown scars on left arm, forearm, lower legs, and feet. On left cheek a group of minute dark-brown scars, site of previous eruptions.

Separated from parents January 19, 1938, at 17 months.

(N) February 4, 1938. Pea-sized, fresh, pinkish scars on dorsum of right forearm, and similar dark-brown scars on feet, anteriorly on ankles, posteriorly on legs, and buttocks. Bean-sized, dry ulcer posteriorly on left thigh. One inch above right knee a pale pinkish area, about 7 by 5 mm, very slightly raised, suspicious.

(N) February 19, 1938. Above lesion of February 4, pinkish, slightly shiny, elevated, 8 by 3.5 mm, showing a very narrow, faint, pale halo.

(N) March 8, 1938. Above lesion of February 4, a fairly distinct, faint, light purplish, elevated area, 10 by 5 mm, very slightly hypopigmented, with a linear scar in center from smear taking.

(N) *March 28, 1938; probable lesions:*

(*a*) Above lesion, above right knee, now 12 by 5 mm, hypopigmented, slightly pinkish, slightly elevated (biopsied).

(*b*) On ulnar aspect of middle right forearm a hypopigmented, pinkish, very slightly thickened, slightly indurated area, 10 by 12 mm, a new suspicious lesion.

Comment.—No previous blemishes noted above right knee, the site of biopsy. Previous blemishes on dorsum of right forearm were pea-sized, fresh, pinkish scars, in February, 1938.

CASE 10. REN. TAB., 2 years and 3 months old on day of biopsy. Posteriorly on right leg. First noted February 12, 1938, as a purplish, scarlike area, apparently markedly indurated, positive (++) for *M. lepræ* on this date. February 26 this lesion resembled a dark-brown, shiny scar, slightly raised and distinctly indurated, the whole area 10 mm in diameter. March 12, 1938, when it was biopsied, this lesion was a purplish-looking scar, thickened, elevated, about 9 mm in diameter, markedly indurated deeper in the skin. Incised once for smears, February 12, 1938.

Histological.—Section shows a very superficially located and very thin scar involving a thin stretch of the papillary layer, 2 mm long (slide 3), with many dilated blood vessels (Plate 3, figs. 8 and 9), some with thin walls, others thick-walled. In all serial sections examined this superficial thin scar was present, and in no instance was it found to involve the reticular layer. In the papillary and subpapillary layers are closely set epithelioid and tuberculoid lesions extending deeply into the lower-most portion of the reticular layer and for some distance on either side of the superficial scar (Plate 3, figs. 8 and 9). The epithelioid and tuberculoid lesions are so extensive and closely set that one smooth hair muscle is found split extensively, groups of its fibers being separated for some distance from each other and invaded by the proliferating epithelioid cells. The superficially located epithelioid lesions in the papillary layer below the superficial scar appear intact and undisturbed and in close contact with the germinal epithelium at one point at one end of the very superficial scar (slide 6). A few Langhans's giant cells and prominent round-cell infiltrations in the large tuberculoid lesions in the deep corium. Perivascular round-cell infiltration slight, and not a prominent feature at the edge of the lesion where it joins the normal skin at one end. In the aniline-blue sections small nerve trunks in the smaller perivascular epithelioid collections near the border of the lesion (slides 4 and 12), but none in the larger, closely set lesions. These nerve trunks show early involvement of their epineural sheaths. Many acid-fast bacilli of variable morphology, some long (Plate 3, fig. 10), some short, some granular, and others segmented (Plate 3, fig. 11) (slide 1, section 3).

Comment.—Whether the superficial thin scar here noted was the original scar observed clinically before the incision was made for smear taking, February 12, or the result of the incision made on that date, cannot be definitely stated. As the epithelioid and tuberculoid lesions immediately beneath this superficial scar appear undisturbed and no scar deep enough can be found in all the serial sections examined, it is probable that this superficial thin scar was the original scar before the incision was made, and that the incision scar was not included in the biopsy.

Protocol.—Born December 14, 1935. Separated from parents at 15 months. Positive (++) in the upper right thigh and (+) in the lower right thigh February 4, 1938, and (++) posteriorly on right leg, February 12, 1938, the last the site of biopsy, March 12, 1938.

Previous skin blemishes and relation to probable lesions:

(C) April 3, 1936. Scattered superficial ulcers, probably of scabies, on feet, right leg, forearms, hands, and right side of nose. Crusted eruptions, superiorly on scalp.

(C) May 22, 1936. Just recovering from extensive scabies of trunk and extremities. No further active lesions of scabies.

(C) July 29, 1936. Numerous minute pale scars on trunk and extremities, due to extensive scabies. Drying superficial ulcers on right forearm, posteriorly on right thigh, apparently also scabies.

(C) September 22, 1936. Ulcerated scabies eruptions on legs and feet, occasional at left elbow and right axillary fold. Many small pale scars on thighs, abdomen, upper trunk, and arms. No suspicious areas.

(C) December 4, 1936. A number of drying scabies on left knee, anteriorly on right leg, on dorsum of right foot, above left external malleolus. Numerous pale scars over trunk and extremities.

(C) February 9, 1937. Fairly numerous pale scars on trunk and extremities.

Separated from parents March 20, 1937, at 15 months.

(N) April 1, 1937. Numerous small pale scars on trunk and extremities. Pea-sized, eroded, slightly inflamed papules one on each lower buttock.

(N) June 1, 1937. Fairly numerous old scars on trunk and extremities. A number of drying vesicopapules on feet and lower legs.

(N) October 11, 1937. A number of drying superficial ulcers on dorsum of left foot and anteriorly on left leg, probably scabies. Numerous closely set, pale scars anteromedially on legs, lower forearms, upper arms, and shoulders. Fewer similar scars on thighs and trunk. Pin-head reddish vesicopapules externally on lower left buttock.

(N) February 4, 1938. Posteromedially on upper right thigh a pinkish-pale, slightly elevated area not surrounded by an inflammatory zone, rather purplish at the middle, 8 by 4 mm, slightly suspicious, positive (++) for acid-fast bacilli. Anteromedially on the lower right thigh, 1 inch above knee, a similar, less distinct area, more definitely suggestive of a subsiding scar but still not distinctly like a scar; this area 5 mm in diameter, with deep purplish, wrinkled center, positive (+) for acid-fast bacilli. Posterolaterally on left arm a reddish-pale papule, about 7 mm, surrounded by a faint pale halo.

Returned to parents in the Colony February 7, 1938.

(C) February 12, 1938. Posteriorly on right leg, just above middle, a pale scar, at the lower border of which is a pin-head, brownish papule. One inch below is a purplish scarlike area which seems markedly indurated, positive (++) for acid-fast bacilli.

(C) February 26. New lesions: medially on left knee a pin-head, reddish, flat papule. Medially on upper left knee a similar, slightly larger, reddish papule with slightly wrinkled surface. Externally on upper left thigh a pinkish, shiny, slightly elevated area, 4 mm in diameter. The pre-

vious lesion posteriorly on right leg now resembling a dark-brown, shiny scar, but slightly raised and distinctly indurated, 10 mm in diameter.

March 12, 1938; positive and probable lesions:

(*a*) On left arm, inferiorly and posterolaterally, a pinkish, shiny lesion, 9 mm in diameter.

(*b*) On right thigh, superiorly and posteromedially, elevated, 8 mm in diameter, positive (++) February 4, 1938.

(*c*) On right thigh, anteromedially, distinctly thickened, 7 mm in diameter, positive (+) February 4, 1938.

(*d*) On left knee, superiorly and medially, shiny, light pinkish, elevated, 6.5 by 5 mm.

(*e*) On left knee, medially, pink, slightly elevated, 4 mm in diameter.

(*f*) On left thigh, superiorly and externally, pink, 6 mm in diameter.

(*g*) On right leg, posteriorly, over purplish-looking scar, about 9 mm in diameter, positive (++) February 12, 1938 (biopsied).

Comment.—Two lesions, one anteromedially on lower right thigh (noted February 4, 1938) and one posteriorly on right leg (noted February 12, 1938), both positive for *M. lepræ* apparently beneath scars or scarlike areas. In the latter, which was biopsied, the original scar was confirmed histologically (Plate 3, figs. 8 and 9). Previous extensive scabies and scars recorded in all regions, showing positive and probable lesions.

CASE 11. VIR. REN., 2 years and 2 months old on day of biopsy. Externally on left lower thigh, 1.5 inches above knee. First noted December 3, 1937, as a small, pale pinkish, very slightly elevated area, about 6 mm in diameter. February 4, 1938, this was still a pale, shiny area, about 8 mm by 6 mm, with scar of incision for smear taking made December 3, 1937. March 28, 1938, it was a pinkish, slightly elevated, rough, slightly indurated area, also hypopigmented, 8 mm in diameter, with pin-point, purplish areas on its surface. Biopsied the next day. Incised December 3, 1937, and on day previous to biopsy, March 28, 1938; negative in both instances.

Histological.—Section shows a small scar, 1.4 mm in diameter (incision of December 3, 1937), extending from middle of corium to surface. Below and to one side of this scar are small foci and strands of epithelioid and tuberculoid lesions in relation to small blood vessels, hairshafts, sweat-gland ducts, and sweat-gland coils. Papillary zone shows several small, perivascular, epithelioid foci (slide 15), some of which are in close contact with the germinal epithelium, causing fraying of the basal cytoplasm in some of the cells. One isolated small nerve trunk in the subcutaneous fat shows a small perineural epithelioid and round-cell lesion. Its nerve sheath is invaded by monocytes, and in the serial sections a capillary with proliferating endothelium is just within the nerve sheath, with several monocytes and epithelioid cells infiltrating the nerve bundle (slides 30 and 31). A small nerve in the deeper corium, which is ensheathed by an epithelioid lesion, shows similar invasive changes by the epithelioid cells (slide 20). One acid-fast bacillus in a lesion close to a smooth hair muscle (slide 17, section 2).

Protocol.—Born January 24, 1936. Separated from parents at 14 months. Never found positive for *M. lepræ* in smears.

Previous skin blemishes and relation to probable lesions:

(C) May 26, 1936. A few pin-head subsiding vesicopapules on trunk and extremities. Dry seborrhœa anterosuperiorly on scalp.

(C) December 4, 1936. Healing minute scabies on feet. Pin-point or larger reddish vesicopapules anteriorly on upper thighs and abdomen. A few pin-point vesicopapules on cheeks.

(C) February 2, 1937. All over face, trunk, and extremities are pin-head to large-pea-sized, rounded, crusted eruptions, surrounded by a zone of slight inflammation.

Separated from parents March 20, 1937, at 14 months.

(N) April 1, 1937. A number of drying scabies on hands, toes, and left plantar. A few larger pin-head or larger than pin-head vesicopapules on abdomen. Small purplish scars on buttocks.

(N) August 4, 1937. Subsiding pea-sized, reddish wheals medially on right arm and medially below left knee. Drying vesicopapule medially on upper right buttock and medially on lower left buttock.

(N) October 1, 1937. No definitely suspicious lesions.

(N) December 3, 1937. (*a*) On upper left knee a small, shiny, pinkish, slightly elevated area, 5 mm in diameter, on each side roughly square. (*b*) Externally on left thigh, 1.5 inches above level of knee, a small, pinkish, very slightly elevated area, 6 mm in diameter. (This lesion biopsied March 28, 1938.) (*c*) Medially on upper left knee a small, similar area, not as pinkish as that on upper left knee. (*d*) Externally on middle of right thigh a small, pale pinkish, elevated, wheallike area, without red areola.

(N) February 4, 1938. Externally on lower left thigh a small, pale, shiny area, about 8 mm by 6 mm. Other lesions, mentioned above, December 3, still present.

(N) *March 28, 1938; probable lesions:*

(*a*) Anteriorly on middle of left thigh a pale pinkish area, very slightly elevated, about 4 mm in diameter, may be a scar.

(*b*) Externally on lower left thigh, about 1.5 inches above knee level, a pinkish, slightly elevated, rough, slightly indurated area, also hypopigmented, 8 mm in diameter, with pin-point, purplish areas on its surface (biopsied).

(*c*) On upper left knee a similar, pale, slightly thickened area, 11 mm in diameter, with a central minute papule.

(*d*) Externally on upper right thigh a small, hypopigmented, not distinctly elevated area, 5 mm in diameter, with a purplish, pin-point spot in the central portion.

Comment.—Previous skin blemishes were vesicopapules on extremities, in May, 1936; vesicopapules anteriorly on upper thighs, December, 1936; pin-head to large pea-sized, crusted eruptions on extremities, in February, 1937; one lesion, observed March 28, 1938, anteriorly on middle of left thigh, probably a scar.

CASE 12. GRE. AMA., 1 year and 10½ months on day of biopsy. Posterolaterally on right thigh. First noted February 19, 1938, as a pinkish elevated area about 2½ mm in diameter, surrounded by a faint, narrow, pale halo. March 8 it was still a pinkish flattened papule, but slightly larger, about 5 by 3 mm, still surrounded by a faint, pale halo. March 29, 1938,

when it was biopsied, it was a deep-pink papule, 5 mm in diameter. Incised for smear taking once only, March 8, 1938; negative for acid-fast bacilli.

Histological.—Sections show a deep scar, 2 mm long (incision of March 8, 1938) near one end and extending through two-thirds of the depth of the corium. Embedded in the scar are small foci of epithelioid and round-cell collections. Beneath the scar and to one side close to it are medium-sized and small epithelioid and tuberculoid foci with a few Langhans's giant cells in relation to hairshafts, blood vessels, a small nerve trunk, and sweat glands. The papillary layer to one side close to the scar shows a narrow stretch of epithelioid lesion in close contact with the germinal epithelium (slide 25) causing fraying of the basal cytoplasm of their cells in places and one or two monocytes invading the deeper epidermis (Plate 1, fig. 4). In the aniline-blue sections a small nerve trunk in the deeper corium ensheathed with epithelioid and cut longitudinally shows a local swelling at one point along its course, with separation and fraying of its delicate, blue-staining, wavy connective tissue (slide 7). Other small nerve trunks in cross section show no appreciable changes, although they are ensheathed by epithelioid or tuberculoid lesions. Border of lesion appears to end rather abruptly, except for slight perivascular round cells in the papillary layer toward the normal skin. Two atypical acid-fast granular bacillary forms (?) found in a superficial lesion (slide 23, sections 1 and 2).

Protocol.—Born May 9, 1936. Separated from parents at 12½ months. Never found positive in smears.

Previous skin blemishes and relation to probable lesions:

(C) July 29, 1936. One small wheal externally above right knee.

(C) December 4, 1936. A number of pin-point to pea-sized reddish vesico-papules on upper back.

(C) February 2, 1937. Many drying minute vesicopapules on feet and lower legs. Above and below right cubital fossa are patches of dark-red, thickened, closely set vesicopapules.

(C) April 3, 1937. Minute fading pale scars on chest.

Separated from parents, May 29, 1937, at 12½ months.

(N) June 1, 1937. Fairly numerous fresh, dark-brown scars and some healing lesions, apparently of scabies, on legs, thighs, and buttocks, fewer on upper extremities.

(N) February 19, 1938. On middle right buttock a deep-pink papule, about 3 by 2 mm. Posterolaterally on middle of right thigh a pinkish, slightly elevated area, about 2.5 mm in diameter, surrounded by a faint, narrow, pale halo (biopsied March 29, 1938). A hazy pale area medially on upper left buttock, about 50 by 20 mm. A hazy pale area anteriorly on upper right leg, slightly shiny and with a very slightly elevated center, the whole 10 by 5 mm. Externally on upper right leg two pin-point, reddish papules, slightly shiny, surrounded by a very faint pale halo. Medially on dependent portion of right buttock a pale-pinkish, slightly elevated area, 2.5 by 2 mm.

March 28, 1938; probable lesions:

(*a*) On middle of right buttock, a 4-mm deep-pink papule.

(*b*) A similar lesion on dependent portion of right buttock, 3 mm.

(*c*) A similar lesion, posterolaterally on right thigh, 5 mm (biopsied).

(*d*) Externally on upper right leg two similar pale-pinkish papules, each 3 mm in diameter.

Comment.—Previous skin blemishes were fresh, dark-brown scars and some healing scabies lesions on legs, thighs, and buttocks, June 1, 1937.

CASE 13; LAU. PUN., 2 years and 7 months on day of biopsy. Posteromedially on left elbow. First observed February 26, 1938, as a small, shiny, rather rough, hypopigmented area, about 1 cm in diameter, not elevated, with apparently slightly hypertrophied hair follicles. March 31, 1938, this slightly depigmented "goose-flesh" area was still distinct, about 10 mm in diameter, with irregular, slightly granular borders and apparently very minute daughter lesions, slightly hypopigmented near the borders. Biopsied on this day. Incised for smear taking only on day of biopsy, negative. Positive (+) for *M. lepræ* in the right ear lobe, upper portion, August 4, 1937, 7⅚ months before biopsy of left elbow lesion.

Histological.—Serial sections show no histological evidence of scarring. In the papillary layer are many small epithelioid and tuberculoid lesions close to the epidermis, some of them in close contact with the germinal epithelium, causing fraying of the basal cytoplasm of some cells and infiltration with a few monocytes (slides 15 and 25). In the subpapillary and reticular layers, including the superficial layer of subcutaneous fat, are small and medium-sized epithelioid and tuberculoid lesions, with rare Langhans's giant cells around hairshafts, small blood vessels, and sweat glands. One smooth hair muscle is split and infiltrated by a tuberculoid lesion. Two small, thin nerves are found ensheathed in two tuberculoid lesions close to the subcutis (slides 35, 36, and 37) one showing evidence of compression at one point and the other infiltration and splitting of the nerve trunk by the lesions. One acid-fast bacillus in a very superficially located lesion (slide 14, section 4).

Protocol.—Born August 24, 1935. Separated from parents at 14½ months. Found positive (+) in smears for *M. lepræ* in the upper portion of the right ear lobe, August 4, 1937.

Previous skin blemishes and relation to probable lesions:

(C) October 26, 1935. Papular eruptions, more or less diffuse anteriorly and posteriorly on trunk. A few on extremities and back of neck.

(C) December 17, 1935. Fairly numerous, very minute vesicopapules on chest, extremities, abdomen, and middle of back; also a number of dark-brown drying vesicopapules on extremities. Minute dry vesicopapules, or pustules, on feet and around ankles.

(C) February 14, 1936. Fresh scabies lesions on feet; minute papulovesicles on abdomen and back. A few scabies lesions on hands. Reddish indurated areas at both antihelices.

(C) July 29, 1936. Feet and ankles dirty due to numerous pigmented scars. Lower legs with numerous, brownish, minute, subsiding vesicopapules, fewer similar lesions on thighs.

(C) September 23, 1936. Extensive, dark, minute scars on buttocks, thighs, legs, and feet. On legs a few minute papulo-vesicular eruptions, a few also at interscapular region.

Separated from parents November 14, 1936, at 14½ months.

(N) December 3, 1936. Numerous fading, minute, dark-brown scars and subsiding vesicopapules on thighs and legs. Two minute, crusted, healing

eruptions on lower right buttocks. A few pin-head vesicopapules on penis and scrotum.

(N) February 1, 1937. A number of healing scabies around ankles.

(N) June 1, 1937. On upper margin of right ear lobe an oval reddish area, about 6 by 3 mm, apparently soft, not eroded.

(N) August 4, 1937. Above lesion, on right ear lobe, prominent, distinctly reddish, but soft, positive (+) for *M. lepræ* in smears.

A number of pale, depigmented, small areas with rough granular borders and granulations even of the surface, varying in size from 1 cm to 4 by 1.5 cm, located—

(*a*) On left side of chest; (*b*) above and 1 inch below left major trochanter; (*c*) on dependent portion of right buttock, and 1.5 inches below it; (*d*) externally over middle of right leg; (*e*) posterolaterally over middle of left leg; and (*f*) anterolaterally over upper part of right forearm. On left lumbar a hazy pale area with prominent follicles, about 2 inches in diameter.

Lesion *c*, *d*, *e*, and *f*, above, are suspected to be tuberculoid lesions.

Child returned to parents in the Colony August 5, 1937, as a positive case from the right ear lobe.

(C) October 1, 1937. Ulcerated scabies and dark scars on feet, legs, and knees. A few pin-head vesicopapules on ulnar side of hands and back. Previous depigmented areas of August 4 still distinct and still somewhat granular, others apparently smoother.

(C) December 9, 1937. Posteromedially on middle of right thigh a pale area, 1 cm in diameter, showing pin-head, flattened papules near its upper margin. Positive lesion on right ear lobe, 10 by 6 mm, distinctly red and rounded. A number of brown and pale scars on hands, wrists, buttocks, posteriorly on thighs and legs, upper back, externally on left arm. Fairly numerous fresh scars and some drying pea-sized eruptions, probably scabies, on dorsum of feet, anteriorly on ankles, medially above left knee, and posteriorly on right ankle.

(C) February 7, 1938. A number of pin-head, brownish, drying vesicopustules, anteriorly on thighs, abdomen, chest, anteriorly on arms, axillary and dorsal. Previous lesion posteromedially on middle of right thigh is a pale area, 13 by 10 mm, showing a linear scar from smear taking. Positive lesion on right ear lobe still reddish, shiny, 15 by 7 mm.

(C) February 26, 1938. Near left elbow, posteromedial aspect, a small, shiny, rather rough, hypopigmented area, 1 cm in diameter, not elevated, with apparently slightly hypertrophied hair follicles.

(C) *March 31, 1938; positive and probable lesions:*

(*a*) Positive lesion on upper right ear lobe seems smaller and more like a wheal, 8 by 6 mm, slightly reddish.

(*b*) Slightly depigmented area posteromedially on middle of right thigh, 15 by 10 mm, still fairly distinct but not showing distinct goose-flesh surface.

(*c*) Slightly depigmented goose-flesh area posteromedially on left elbow, still distinct, 10 mm in diameter, with irregular, slightly granular borders and apparently very minute daughter lesions, slightly hypopigmented near borders (biopsied on this day). No other definitely suspicious lesions.

Comment.—Previous skin blemishes were a few papular eruptions on extremities in October, 1935, numerous minute vesicopapules and dark-

brown drying similar lesions on extremities in December, 1935, reddish indurated areas on antihelices in February, 1936, subsiding vesicopapules on thighs in July, 1936, extensive minute scars on thighs in September, 1936, numerous fading, dark-brown scars and subsiding vesicopapules on thighs in December, 1936, pin-head vesicopapules on forearms in October, 1937, brown and pale scars posteriorly on thighs and externally on left arms in December, 1937, and pin-head, brownish, drying vesicopustules anteriorly on thighs and anteriorly on arms in February, 1938.

Because of the unusual site of the positive lesion in the upper right ear lobe, a personal inquiry from the parents of the child was made. The mother said she remembered that the child had scabies of the ears at the age of 6 months. This report tallies with the observations of reddish indurated areas on both antihelices, February 14, 1936, when the child was about 6 months old. The father, quite intelligent, declared that the child had had scabies behind the right ear, very close to the site of the positive lesion on the upper margin of the right ear lobe.

CASE 14. PRE. PAR., 3 years and 4 months on the day of biopsy. Above left popliteal. First noted April 7, 1937, 11 months before biopsy, as a small, bean-sized, pale-pinkish, slightly raised, shiny area, a scar, according to the father. June 4, 1937, this pale pinkish area, suspected of being a "scar," was still quite distinct and appeared different from other scars in the vicinity. August 6, 1937, it was distinct, about 1 cm in diameter. October 1, 1937, it was still distinct, with a pinkish-brown center. December 6, 1937, it appeared slightly larger but less elevated, with a brownish center. February 7, 1938, it was a pale area, 10 by 8 mm. Biopsy March 12, 1938. Incised for smear taking August 6, 1937, and October 11, 1937; negative for acid-fast bacilli in both instances.

Histological.—Biopsied specimen very small. Serial sections show no evidence of scarring. At one end the papillary layer shows some perivascular round-cell infiltration, mixed with several large monocytes apparently undergoing very early epithelioid changes. None in contact with epidermis. In the subpapillary and reticular layers are three medium-sized epithelioid and tuberculoid lesions in relation to a hairshaft and a group of coils of sweat glands. Close to the subcutis (slide 10) a small nerve trunk with perineural epithelioid infiltration shows involvement of the epineural sheath, and one large monocyte with a homogenous eosin-staining cytoplasm among the nerve fibrils. No scar of incision from smear taking was found, possibly not included in the biopsied specimen. Acid-fast bacilli could not be demonstrated in any of the large number of sections examined.

Comment.—This lesion was suspected of being a scar 11 months before biopsy. The absence of any histological evidence of scarring may be due to regeneration of the elastic tissue, or noninclusion of the scarred area in the biopsy, which was very small.

Protocol.—Born November 18, 1934. Separated from parents at 11 months, October 14, 1935. Released to relatives January 14, 1936. Returned to Culion from San Lazaro Hospital, Manila, said to have been found positive in smears for *M. lepræ* in the sacral region January 21, 1936, at the age of 14 months. Biopsy report of positive lesion at San Lazaro: "Perivascular infiltration. Cannot be examined for *M. lepræ*, due to accidental use of Xylol." Returned to parents in the Colony March 11,

1936. Never been found positive in smears after return to Colony, from March, 1936, up to March, 1938.

Previous skin blemishes and relation to probable lesions:

(C) May 10, 1935. Anteriorly on thighs many hazy pale areas, on left thigh one lesion with a small brownish center, another lower down with a red wheal at center.

(C) August 21, 1935. Cheeks slightly rough, due to a few minute, papular irritations. Ill-defined pale areas anteriorly on thighs and anterolaterally on legs, the latter very slightly shiny.

Separated from parents October 14, 1935, at 11 months.

(N) October 28, 1935. A few moist, ulcerated eruptions on scalp, one on right cheek.

(N) December 4, 1935. Healing, crusted eruptions above right buttock and over occipital. A few active scabies on right small finger.

(N) December 14, 1935. Dark, reddish-brown, corn-sized scar on middle of right cheek.

Returned to parents in Colony March 11, 1936, found positive in the right sacral in San Lazaro Hospital, Manila, January 21, 1936 (*see* first paragraph under protocol, above).

(C) March 14, 1936. Fairly numerous, scattered, pin-head vesicopapules on buttocks, back, and extremities, and active scabies lesions on feet, lower legs, and posteriorly on left thigh.

(C) April 10, 1936. Extensive, scaling, superficially ulcerated eruptions on legs, less marked on upper abdomen, a few anteriorly on right thigh, cheeks, back, and right hand.

(C) May 28, 1936. Fairly numerous drying scabies on feet, ankles, and hands. Extensive brown scars on legs. A pea-sized, red, eroded vesicopapule posteriorly on left thigh.

(C) July 31, 1936. A few pin-head to pea-sized vesicopustules posteriorly on thighs, probably scabies.

(C) September 22, 1936. Some thickened, dark scars on inner side of thighs and below buttocks.

(C) April 7, 1937. Numerous dark-brown scars on trunk, thighs, buttocks, and legs. Above left knee and externally on middle of left thigh and posteriorly on lower left thigh (above left popliteal) three small, pale, pinkish, slightly raised, shiny areas, scars according to the father.

(C) June 4, 1937. Above suspected "scars" appear different from other scars in the vicinity, being slightly pinkish, slightly thickened, and slightly shiny.

(C) August 6, 1937. Pale pinkish areas on the left thigh are distinct, 1 to 1.5 cm in diameter, slightly raised.

(C) October 1, 1937. Previous pale areas posteriorly on lower left thigh, externally on left thigh, and above left knee still distinct, with pinkish-brown centers; the first two with slightly elevated centers. They do not seem to be increasing in size, but a pale halo adjoins lateral portion of area above left knee and upper portion of area externally on left thigh. A number of pea-sized or smaller papulopustules anteriorly on thighs, left elbow, and a few on buttocks.

(C) December 6, 1937. Previous three pale areas appear slightly larger but less elevated and now have brownish centers. No new suspicious le-

sions. A number of pea- to bean-sized, drying, crusted eruptions, posteriorly on thighs, buttocks, sacral, left forearm, medially on right arm.

Positive and probable lesions:

(*a*) January 21, 1936, on right sacral a superficial brownish area surrounded by a pale areola. (Found positive in smears, and biopsied at San Lazaro Hospital.)

February 7, 1938, the following probable lesions were noted:

(*a*) A pale area above left popliteal (posteriorly on lower left thigh), 10 by 8 mm, slightly raised. (Biopsied in Culion, March 12, 1938.)

(*b*) Externally on middle of left thigh a similar pale area, 10 mm in diameter, slightly raised.

(*c*) Above left knee a similar area, 25 by 10 mm, also slightly raised.

(*d*) A pale area, 8 mm in diameter, medially over left elbow.

Comment.—Previous skin blemishes were healing, crusted eruptions above right buttock December 4, 1935; numerous vesicopapules on extremities, and active scabies lesions posteriorly on left thigh in March, 1936; a pea-sized, eroded vesicopapule posteriorly on left thigh in May, 1936; vesicopapules posteriorly on thighs in July, 1936; thickened dark scars on inner thighs and below buttocks in September, 1936; pale pinkish suspected scars above left knee, externally on middle of left thigh, and posteriorly on lower left thigh in April, 1937; papulopustules anteriorly on thighs and left elbow in October, 1937; and crusted eruptions posteriorly on thighs and left forearm in December, 1937.

DISCUSSION

Of the fourteen biopsied cases here reported, the lesions as they were first observed clinically were as follows:

In one, a hazy pale area, about 1 cm in diameter, 3½ months before biopsy, which became a smaller, hypopigmented, pink, slightly raised area, 5 by 4 mm, at the time of biopsy (case 2).

In two, a pale area, 25 by 15 mm, slightly granular, in the lower portion (case 4), and a small, shiny, rather rough, hypopigmented area, about 10 mm in diameter, not elevated, with apparently slightly hypertrophied follicles (case 13).

In three, scarlike, two of them being definitely indurated scars (cases 3 and 10), while one was a small, pale pinkish, slightly raised, shiny area (case 14).

In eight, flat, wheallike, in three of them as pinkish, slightly shiny papules, from pin-head to 3 mm in diameter (cases 6, 7, and 8) and in five as small, pale pinkish, or pinkish shiny, thickened, or slightly elevated areas, varying from 2.5 mm in diameter to 7 by 5 mm (cases 1, 5, 9, 11, and 12).

Of the above fourteen cases, in eight the lesions were definitely papular or thickened when first observed (cases 1, 5, 6, 7, 8, 9, 11, and 12), at periods varying from 8 days to 3 months and 3

days before biopsy. In a ninth case (case 2) the pink papule, 5 by 4 mm, was preceded by a hazy pale area 3½ months before biopsy, and in a tenth case (case 14) it was scarlike. In four of the above cases (6, 7, 8, and 9) and in one indurated scar (case 10), three were found positive (++) to (+++) for *M. lepræ* in smears on the day the lesions were first discovered (cases 6, 7, and 10), one (case 8) (+) on the day of the biopsy, and one (case 9) was found positive (+) in the remaining half of the lesion left in the child for further clinical observation, a little over 2 months after biopsy.

As already mentioned in the first part of this paper, Lara and de Vera(9, 10) were apparently the first to point out the occurrence of an unrecognized characteristic leprotic papule, usually positive for *M. lepræ*, occurring very early in infants of leprous parents that have become declared lepers. Chiyuto(2, 3) has mentioned similar lesions, but no smears were made from the lesions of his cases, and in five biopsies, which were apparently histologically tuberculoid lesions, no acid-fast bacilli were demonstrated. Wade,(26, 27) in a study of South African tuberculoid material, was able to demonstrate acid-fast bacilli only in what he considered reacting cases, but none in the nonreacting cases. On the other hand, Lie(11) claims to have been able to demonstrate the bacillus in all ten South African specimens he examined, four of which were considered typical examples of tuberculoid leprosy, and suggested that the search for the bacilli should be made patiently, carefully, and systematically.

Concerning the presence of acid-fast bacilli in the sections from our cases (Plate 3, figs. 10 and 11) a special effort was made to find them, at times a whole day being employed in the examination of one case. The findings were as follows: in four (cases 6, 7, 9, and 10) they were from several to many and easily found; in seven (cases 1, 3, 4, 5, 8, 11, and 13) they were scanty, or very scanty, and only one or two were found in from several to many sections examined; in two (cases 2 and 12) doubtful acid-fast bacilli were found; and in one (case 14) no acid-fast bacilli could be demonstrated. As *M. lepræ* presents very variable forms in the tissue sections, as has been observed in case 10, the two doubtful cases might also have been declared positive, except for the absence of other definite bacillary forms in the tissues. One interesting finding is the occurrence of one acid-fast bacillus in a focus of round-cell collection in the section showing only perivascular round-cell infiltration (case 4).

Histologically, of these fourteen cases, eleven (cases 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14) showed definite epithelioid and tuberculoid changes (Plate 3, figs. 8 and 9); in two (cases 2 and 3) some of the large monocytes in the lesions showed early epithelioid changes (Plate 1, fig. 1); and in one (case 4) only perivascular round-cell infiltrations mixed with a few monocytes were found. An interesting finding in the case with perivascular round-cell infiltrations is the splitting and infiltration of the smooth hair-muscle bundles by the infiltrating cells (Plate 1, fig. 2). In all the tuberculoid sections the smooth hair muscles were definitely invaded, producing splitting and isolation of groups of the muscle fibers.

The tuberculoid lesions were invariably distributed around blood vessels, hairshafts, and smooth hair muscles, sweat-gland ducts, and coils and small nerves. In most the lesion foci were small or medium-sized, while in one (case 5) they were fairly extensive, and in another (case 10) extensive and closely set (Plate 3, fig. 8). In the papillary layer the lesions in most of the cases consisted of a thin layer of epithelioid or tuberculoid lesions side by side, from which downward prolongations of the lesions into the deeper corium could be traced in serial sections.

In eleven cases, ten of which were definitely tuberculoid lesions and one showed only beginning epithelioid changes of the large monocytes, the most superficially located lesions were found to be in close contact with the germinal epithelium, seemingly producing fraying of the basal cytoplasm of their cells. In five of these (cases 1, 5, 7, 12, and 13) besides fraying of the basal cytoplasm of the germinal epithelium, there was also concomitant invasion of the deeper layers of the epidermis by a few monocytes (Plate 1, figs. 3 and 4). Wade(26) has already described similar changes in tuberculoid leprosy from South African material. To verify this point from Philippine material, twelve sections from tuberculoid leprosy cases in Culion on file in our laboratory were examined and showed similar changes.

Concerning the nerves in the sections, which are ordinarily surrounded or ensheathed by epithelioid or tuberculoid lesions, no apparent involvement was found in three (cases 2, 3, and 4), but in the other eleven cases the surrounding epithelioid or tuberculoid lesions have been found apparently invading their epineural sheaths in three (cases 7, 8, and 10), and actual invasion of the nerve fibers, either by monocytes or epithelioid cells in eight (cases 1, 5, 6, 9, 11, 12, 13, and 14). In five of these eight cases

from one to several monocytes were found infiltrating the nerve fibers (Plate 2, fig. 7); in one (case 5) from partial to complete tuberculoid infiltration of the nerve trunk (Plate 2, figs. 5 and 6); and in two (cases 12 and 13) swelling or infiltration with separation of the delicate blue-staining connective tissue of the nerves. These changes in the nerves due to invasion by the perineural lesions, however, were not uniform, being found only at certain levels in the serial sections examined. One of us (C.B.L.) previously observed in a few instances a lack of feeling on the part of the child when some of the definitely suspicious early papular lesions were first incised for the bacteriological examinations. Wade(26) has mentioned that as a rule the tuberculoid process invades only the outer sheaths when it is invasive at all. Muir and Chatterji(17) and Lowe(12) have shown the fine nerve branches in "tuberculoid" macules infiltrated with "epithelioid." Grieco(7) and Ermakova(4) have also shown invasion of the small cutaneous nerve trunks by lymphocytes and histiocytic, or epithelioid cells.

Special efforts were made also to determine the presence of scars in the section. The incisions for smear taking made on the lesions previous to biopsy interfered somewhat in the microscopic examinations. Of the three lesions (cases 1, 5, and 13) incised only once on the day of biopsy, no scars were found in the sections, and of the eleven that had been incised from 20 days to 7 months before biopsy, definite scars attributable to the incisions were found in nine, while in two (cases 10 and 14) these incision scars were not found, possibly not being included in the biopsies. Two of the lesions (cases 3 and 10) were originally observed clinically as definite scars, or scarlike, and these two cases showed histologically the original scars, besides the incision scar in one (case 3). In the third case, which was suspected of being a "scar" (case 14), no scar could be demonstrated, possibly because of the very small size of the specimen excised.

The finding of three lesions, two of them developing beneath definite scars and one scarlike out of these 14 biopsied cases, leads to the suspicion that previous skin blemishes may possibly play a rôle in the development of these very precocious lesions. The protocols show that two other lesions not biopsied, one anteromedially on the lower right thigh (case 10) and one anteriorly on the middle of the left thigh (case 11) were also suspected of being "scars." In the two lesions biopsied (cases 3 and 10),

the scars were so definite clinically that one cannot avoid suspecting the development of the lesions as a result of the breach of surface continuity of the skin. It is also, however, possible that in these cases the development has been merely fortuitous or accidental, since in many other very early probable lesions no apparent scars were observed when they were first discovered. In these cases, however, where there is no gross evidence of scars, a very superficial previous blemish of the skin may possibly have left no recognizable traces of scarring. Lara and de Vera(9) have already pointed out that various kinds of known nonleprotic skin affections, like prickly heat, eczema, dermatitis, insect bites, scabies, bruises, and other forms of injury, if only superficially involving the skin surface, may leave no scars at all upon healing, but instead only hazy, pale, or depigmented areas.

Analyzing the protocols of the cases here reported for previous skin blemishes, by region, in relation to the sites of both biopsied and not biopsied positive and probable "leprotic" lesions, it has been found that of the 42 regions showing positive or probable leprotic lesions (Table 1), 38 regions showed previous skin blemishes in the form of reddish wheals, vesicopapules of from pin-head to pea-sized, scabieslike lesions, minute pale scars, fresh scars, brown thickened scars, papular eruptions, ulcers—probably scabies, extensive scabies, crusted eruptions, and papulopustules. Only in four regions showing lesions was there no mention in the protocols of a previous skin blemish. Ten regions showed two lesions each in seven cases (cases 1, 2, 5, 10, 11, 12, and 14) three times on the right thigh, three times in the left thigh, and once each on the right knee, left knee, right leg, and right buttock, respectively (Table 1). In Table 2 is shown the regional incidence of localization and the number of lesions in them —fourteen times with 20 lesions in the thighs, six times with 8 lesions in the knees, six times with 7 lesions in the legs, four times with 5 lesions in the buttocks, three times with 3 lesions in the left elbows, two times each with 2 lesions in the right forearm, arms, and cheeks, and only once each with lesion in the right ear lobe, lower lumbar, and right sacral.

Table 2 shows that the larger number of the lesions are mainly on the exposed, or partially exposed regions of the body surface, as the thighs, knees, buttocks, elbows, forearms, arms and cheeks. Only in three instances were the lesions localized in the ear lobe, lower lumbar, and right sacral, one lesion in each

case. Although 13 of these 14 children showed previous skin blemishes on the trunk, only two lesions (lower lumbar and right sacral) developed in the trunk, compared with the other exposed regions of the body. This may indicate that the clothing worn by the child to some extent helped in protecting the covered portions of the body from the infection.

Marchoux and Sorel,(16) working on rat leprosy, were unable to produce infection in eight 8-day-old rats whose skins were still soft by painting the apparently intact skins over a large area with bacillary suspensions of rat leprosy, and concluded that the intact skin of young rats resists the penetration of the germs. On the other hand, Sakurai,(23, 24, 25) in a tabulated summary of experimental studies on the penetration of lepra bacilli through the skin in one neural case of leprosy, and in rabbits and mice, has shown that there was most penetration in injured skin, next in skin from which the hair had been pulled, third through the normal skin when the emulsion was rubbed in, fourth through the mucous membranes of the eyelid and nostril, and least in healthy skin without friction. In his lone human experiment(23), a few bacilli, or globi, were found in a minute chap of the skin that could not be seen with the naked eye.

The multiple lesions varying from 2 to 7 in these fourteen children (Table 1), except two (cases 3 and 8) that apparently had only one lesion each in the legs, suggest multiple sites of infection through the skin, apparently favored by previous skin disease. This possibility is definitely suggested in one positive, oval, reddish lesion (case 13) of unusual location in the right ear, which had a history, according to the father, of scabies behind the right ear close to the site of the positive lesion in the upper border of the ear lobe.

It might also be argued and assumed that the recognizable early lesions in these cases had been latent infections (possibly lying latent in the deep organs or skin) which became manifest at these unusual early ages. This explanation is possible, but in an unpublished histological study on the presence of leprotic lesions and acid-fast bacilli of the deep organs (spleen, liver, lymph nodes, and nerves), by both the paraffin and frozen methods of sectioning, of 58 necropsied children in Culion, all below 2 years of age, none was found positive.(21) Similar unpublished histological examinations(21) of "hazy depigmented areas" of the skin, of the type first described by Chiyuto(1) in

TABLE 1.—*Regional distribution of positive and probable lesions and previous skin blemishes.*

Case.	Name.	Age.		Sex.		Region.	Number of positive and probable lesions.	Previous skin lesions.	
		Years.	Months.	Male.	Female.			Presence or absence.	Kind.
						Right thigh	2	[a] —	None.
						Right leg	1	+	Scabieslike lesions and scars.
1	Jos. Lun.	2	4	—	+	Left thigh [b]	2	+	Vesicopapules.
						Lower lumbar	1	+	Numerous pale and brownish scars.
						Left cheek	[c] 1	+	Vesicopapular eruptions.
						Right thigh [b]	2	+	Minute pale scars, probably scabies.
2	Moi. Miñ.	2	6½	+	—	Right buttock	1	+	Do.
						Left buttock	1	[a] —	None.
3	Bue. Mia.	1	8½	+	—	Left leg [b]	1	+	Lesion actual scar, probably scabies.
4	Sul. Dia.	1	11	+	—	Right thigh [b]	1	+	Scars and vesicopapules, probably scabies.
						Left thigh	1	+	Do.
						Left leg	1	+	Fresh scars, probably scabies.
						Above left elbow [b]	1	[a] —	None.
5	Rod. Abe.	1	11½	+	—	Left knee	1	+	Vesicopapules.
						Right knee	[d] 2	+	Do.
						Right cheek	1	+	Reddish wheals.
6	Ern. Vib.	1	9	+	—	Right thigh [b]	[d] 1	+	Dark-brown spots and scars, probably scabies.
						Right forearm	1	+	Dark-brown spots, probably subsiding wheals.
						Right arm [b]	[d] 1	+	Papular eruptions and scar.
7	Epi. Gal.	1	8	+	—	Right thigh	[d] 1	+	Scars, ulcers, probably scabies.
						Left buttock	1	+	Vesicopapules and ulcers, probably scabies.
8	Edi. Uro.	2	8	+	—	Left leg [b]	[d] 1	+	Reddish wheals, vesicopapules, and scars.
9	Ana. Man.	1	7½	+	—	Right knee [b]	[e] 1	[a] —	None.
						Right forearm	1	+	Scars, probably scabies.
						Left arm	1	+	Extensive scabies and scars.
						Right thigh	[d] 2	+	Do.
10	Ren. Tab.	2	3	+	—	Left thigh	1	+	Do.
						Left knee	2	+	Do.
						Right leg [b]	[d] 1	+	Do.

11	Vir. Ren.	2	2	—	+	Left thigh [b]	2	+	Vesicopapules, crusted eruptions, scars.
						Left knee	1	+	Reddish wheals.
						Right thigh	1	+	Vesicopapules, crusted eruptions.
12	Gre. Ama.	1	10½	—	+	Right buttock	2	+	Scars, probably scabies.
						Right thigh [b]	1	+	Do.
						Right leg	2	+	Do.
13	Lau. Pun.	2	7	+	—	Right ear lobe	[d] 1	+	Indurated areas, scabies according to the father.
						Right thigh	1	+	Vesicopapules, scars, probably scabies.
						Left elbow [b]	1	+	Do.
14	Pre. Par.	3	4	—	+	Right sacral	[f] 1	+	Crusted eruptions.
						Left thigh [b]	2	+	Vesicopapules, scars, probably scabies.
						Left knee	1	+	Vesicopapules, probably scabies.
						Left elbow	1	+	Vesicopapules, papulopustules, probably scabies.
	Total			10	4	42	52	38+4—	

[a] None noted down in protocol.
[b] Biopsied.
[c] Positive June 29, 1938.
[d] Positive.
[e] Positive 2 months after biopsy.
[f] Positive at San Lazaro Hospital.

TABLE 2.—*Regional incidence and distribution of positive and probable lesions in the 14 cases examined.*

Region.	Incidence of regional localization.	Number of lesions. Total.	Number of lesions. Positive in smears.
1. Thighs	14	20	4
2. Knees	6	8	2
3. Legs	6	7	2
4. Buttocks	4	5	----------
5. Elbows (left only)	3	3	----------
6. Forearms (right only)	2	2	----------
7. Arms	2	2	1
8. Cheeks	2	2	1
9. Right ear lobe	1	1	1
10. Lower lumbar	1	1	----------
11. Right sacral	1	1	1[a]
Total 11 regions	42	52	12

[a] Positive at San Lazaro Hospital.

20 necropsied Culion children, also under 2 years of age, showed no histological changes from similar normal control skin sections.

While penetration of the intact human skin by *M. lepræ* is possible, the presence and great frequency of skin diseases in these very young children whose surroundings may be considered as heavily permeated with leprosy bacilli, would certainly favor and facilitate implantation of the infection. Because of their multiple localization, and because of their tendency to show *M. lepræ* very early, or as soon as they have been discovered clinically, these early papular thickened lesions may be considered primary inoculation lesions, and may be compared to the primary focal lesions of tuberculosis in the lung parenchyma of children.(19) Their inconspicuousness, unless special efforts are made to find them, has already been mentioned by one of us.(8)

An ideal control for this study would be to prevent the development of skin diseases in a group of children living with their leprous parents. By close medical supervision and a careful daily check-up and treatment of all skin diseases that may develop both in the children and in their parents, it may be possible to bring up children absolutely free from any skin blemishes, to which is in part attributed their early infection. The difficulties in carrying out this suggestion become at once apparent in view of the extreme susceptibility of the tender skin of infants and young children to various types of nonleprotic affections.

SUMMARY AND CONCLUSIONS

1. Fourteen very early "leprotic" lesions from fourteen very young children of lepers from 1 year and 3 months to 3 years and 3 months old were studied histologically.

2. In eight the lesions were clinically definitely papular or flat and wheallike when first observed; in a ninth case the papule was preceded by a hazy pale area; in one it was a pale area slightly granular in the lower portion; in one a rough hypopigmented area with apparently slightly hypertrophied follicles; and in three, indurated scars or scarlike areas.

3. Of the papular lesions, including one indurated scar, examined by the "scraped-incision" method, three were found positive for *M. lepræ* on the day the lesions were discovered, one on the day of the biopsy, and one in the remaining half of the lesion left in the child, a little over two months after biopsy. The others were negative.

4. In the skin sections, acid-fast bacilli have also been demonstrated from several to many in four cases, scanty or very scanty in seven cases, doubtful in two cases, and none in one case.

5. The significance of the non-acid-fast bacillary forms and non-acid-fast diptheroids and coccoids reported in smears and found in the sections, has not been established. As far as the present observations go, they are interpreted to be probably degenerated chromatin material of the numerous cells crowded in the lesions. The need for further investigations to determine their exact nature is mentioned.

6. Histologically, eleven showed definite epithelioid and tuberculoid changes, the lesions invariably distributed around blood vessels, hairshafts, smooth hair muscles, sweat-gland ducts and coils, and small nerves. In most the lesion foci were small or medium-sized, while in one (case 5) they were fairly extensive, and in another (case 10), extensive and closely set (Plate 3, fig. 8). Of the three showing no definite tuberculoid lesions, in two (cases 2 and 3), some of the large monocytes in the lesions showed beginning epithelioid changes (Plate 1, fig. 1) and in one (case 4) only perivascular round-cell infiltrations mixed with a few monocytes (Plate 1, fig. 2).

7. Interesting observations in the section showing only perivascular round-cell infiltrations (case 4) are recorded,—the infiltration and splitting apart of the smooth hair muscle bundles by the infiltrating cells (Plate 1, fig. 2) and the finding of an

acid-fast bacillus in a focus of round-cell collection. The latter biopsy was made from the center of a hazy pale area 28 by 30 mm, with minute papules chiefly along the borders.

8. In eleven cases, ten of which were definitely tuberculoid lesions and one showed only early epithelioid changes of the large monocytes, the most superficially located lesions were in close contact with the germinal epithelium, seemingly producing fraying of the basal cytoplasm of their cells and invasion of the same by a few monocytes (Plate 1, figs. 3 and 4).

9. Early involvement of the fine nerves in the lesions is apparent, as the epineural sheaths were found apparently involved in three cases, actual invasion of the nerve fibers by monocytes was found in five cases (Plate 2, fig. 7) swelling and infiltration of the nerves in two cases, and partial to complete tuberculoid infiltration of the nerve trunk in one case (Plate 2, figs. 5 and 6).

10. In the two lesions originally discovered as developing in definitely indurated scars, apparently of scabies, the original scars were identified histologically in the sections, while in the third, which was suspected of being a "scar," none could be demonstrated histologically, possibly because of the small size of the specimen excised.

11. Because of the multiple lesions, varying from 2 to 7, in these fourteen children, except in two which apparently had only one lesion each in the legs, the possible rôle of previous skin disease in favoring the implantation of the infection is discussed.

12. Although thirteen of these fourteen cases showed previous skin blemishes on the trunk, the rarity of the lesions in the trunk compared with the number of lesions found in the more exposed portions of the body (Table 2), is attributed to the clothing worn by the child, which may to some extent help in protecting the covered portions from the infection.

13. The very early papular thickened lesions studied, because of their multiple localization, inconspicuousness, and tendency to show *M. lepræ* very early, or as soon as they have been discovered clinically, may represent primary inoculation lesions comparable to the primary focal lesions of tuberculosis in the lung parenchyma of children.

14. The difficulties in carrying out a suggested control experiment are mentioned.

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ILLUSTRATIONS

Plate 1

Fig. 1. Large monocytes showing early epithelioid changes. No definite tuberculoid lesion was found in the serial sections of this case. (Moi. Miñ., case 2.) H. & E. stain.

2. Smooth hair-muscle bundle infiltrated by round cells and a few large monocytes, causing splitting and isolation of groups of muscle fibers. In this case all the lesions in the section were perivascular round-cell infiltrations with a sprinkling of a few large monocytes. (Sul. Dia., case 4.) H. & E. stain.

3. Fraying of basal cytoplasm of germinal epithelium and infiltration of the deeper layers of the epidermis with occasional monocytes. (Rod. Abe., case 5.) H. & E. stain. A larger magnification of similar changes is shown in fig. 4 (case 12).

4. Fraying of basal cytoplasm of germinal epithelium and infiltration of the same with monocytes. (Gre. Ama., case 12.) H. & E. stain.

Plate 2

Fig. 5. Partial tuberculoid infiltration of a medium-sized nerve trunk in the subcutis. (Rod. Abe., case 5.) H. & E. stain.

6. Complete tuberculoid infiltration of the nerve trunk shown in fig. 5 at a deeper level in the serial sections. H. & E. stain. This lesion is best shown with Mallory's aniline-blue stain.

7. Monocytes within the capsule of a small nerve trunk and epithelioid invasion of the epineural sheath. (Ana. Man., case 9.) H. & E. stain.

Plate 3

Fig. 8. A superficial scar beneath which are extensive and closely set apparently undisturbed epithelioid and tuberculoid lesions. Note dilated blood and lymph vessels below scaling epidermis. (Ren. Tab., case 10.) Voerhoff's elastic-tissue stain.

9. Higher magnification of superficial scar in the immediate vicinity of the hairshaft shown in fig. 8, marked x. Epithelioid and tuberculoid lesions undisturbed, blood and lymph vessels dilated, and elastic fibers absent in the scarred area. (Case 10.) Elastic-tissue stain.

10. Two long solid forms of *M. lepræ* in tuberculoid lesion (case 10). Acid-fast stain.

11. One segmented form of *M. lepræ* from the specimen shown in fig. 10. Acid-fast stain.

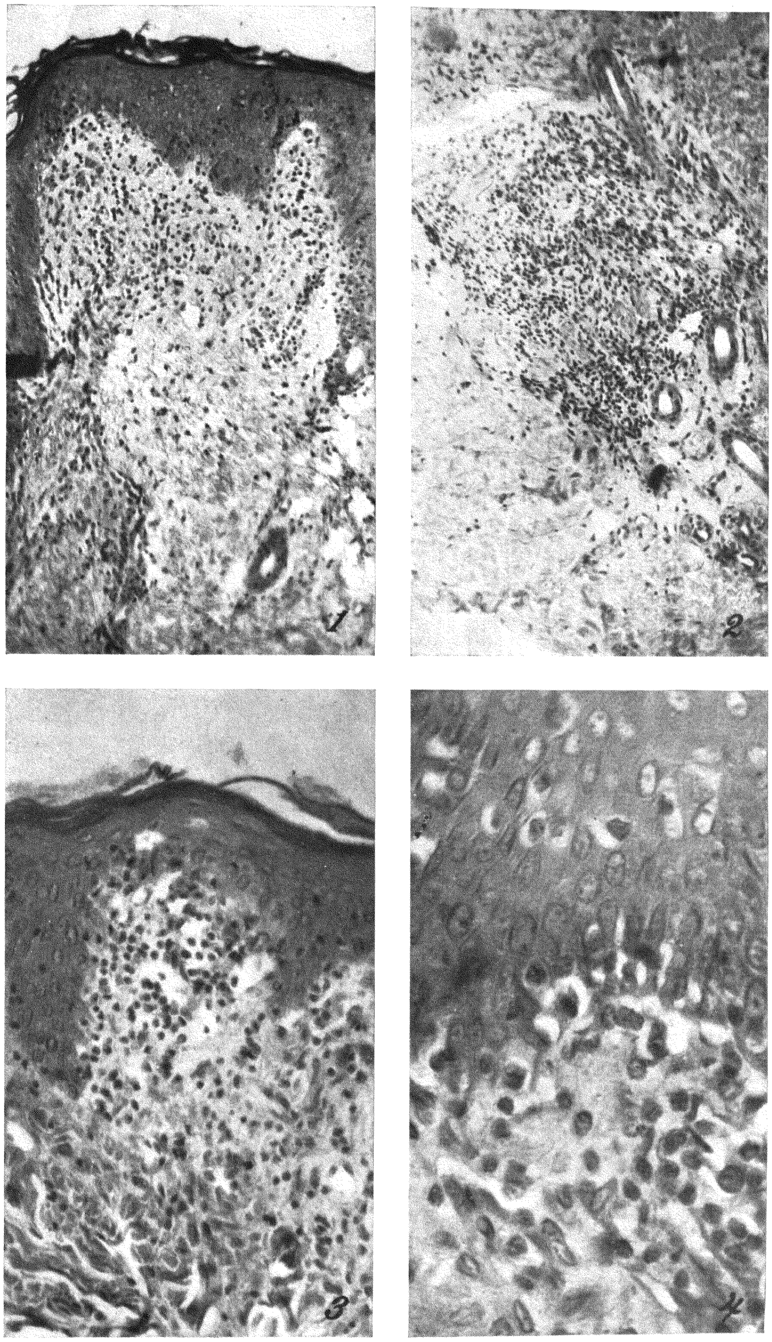
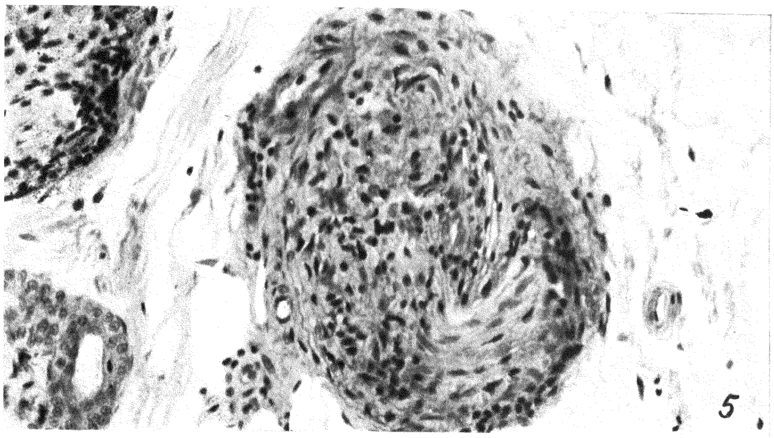
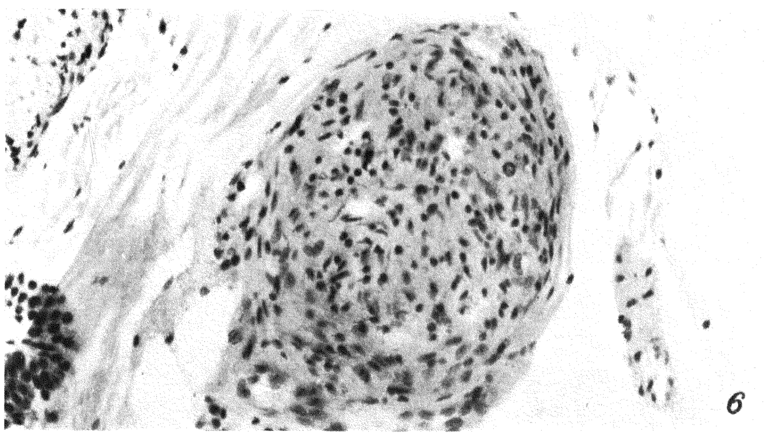


PLATE 1.





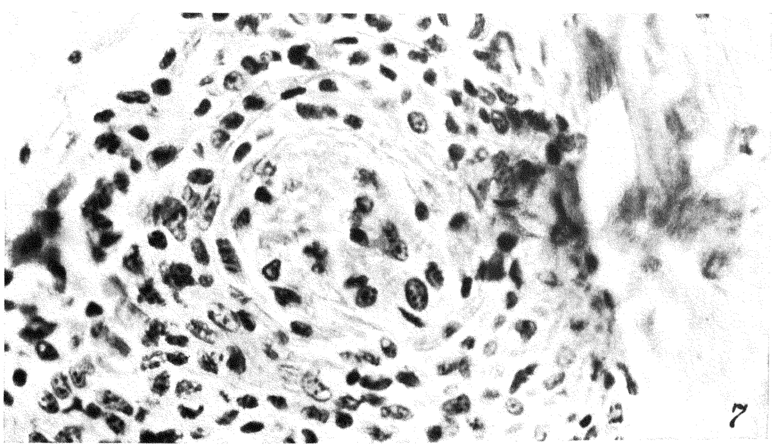


PLATE 2.

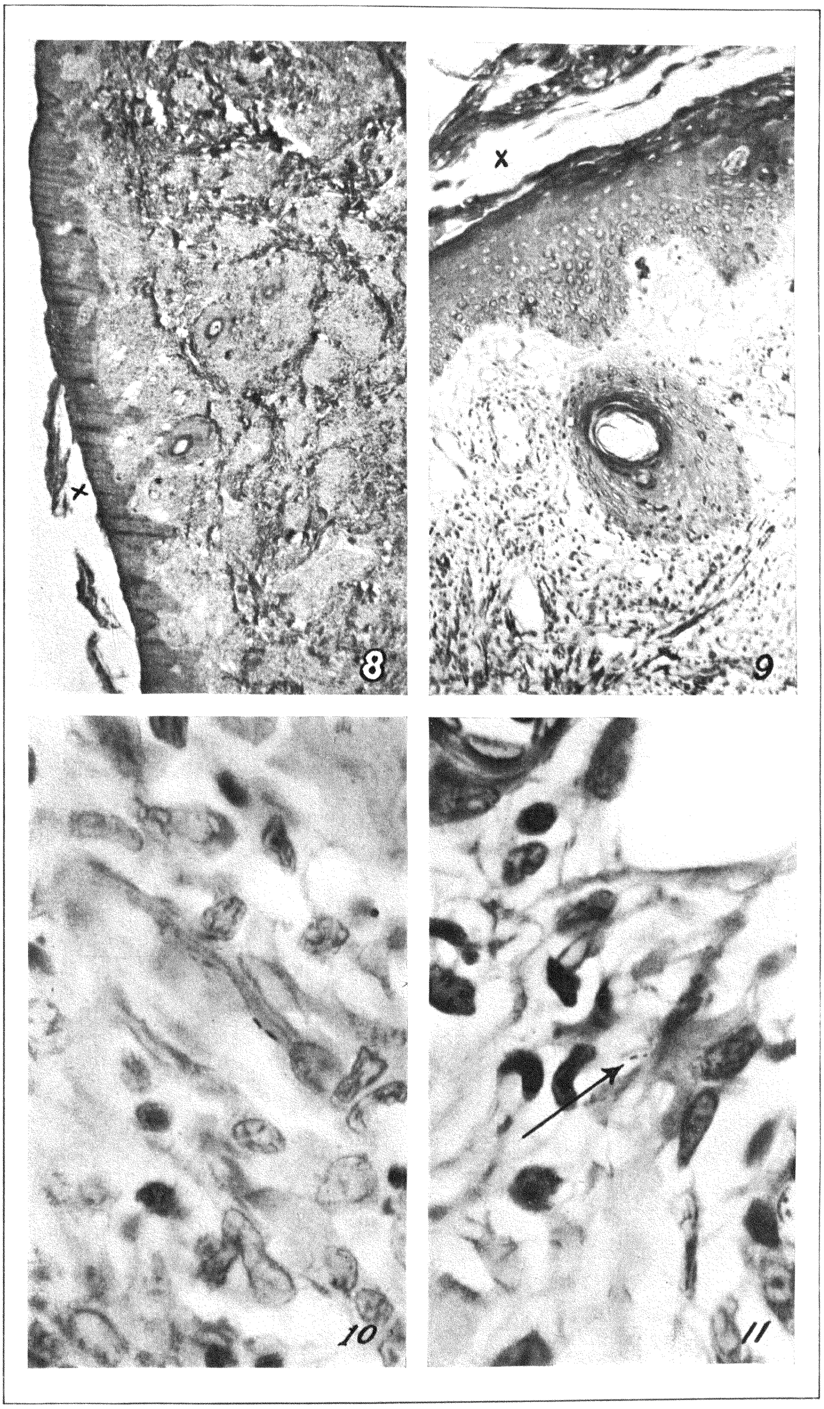


PLATE 3.

PHARMACOLOGICAL STUDY OF QUARTERNARY ALKALOIDS AND FLUID EXTRACT OF PHAEANTHUS EBRACTEOLATUS (PRESL) MERRILL (KALIMATAS)[1]

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TWELVE PLATES

Phaeanthus ebracteolatus (Presl) Merrill is a common and widely distributed plant in the Philippines. In Los Baños, Laguna Province, and in Bataan Province it is known as "kalimatas." The kalimatas bark used in the experiments reported in this paper, and a close picture of the trunk of *Phaeanthus ebracteolatus*, shown in Plate 1, were received from Mr. Mamerto D. Sulit, Forest Supervisor of the Bureau of Forestry, through the National Research Council of the Philippines. I wish to take this opportunity to express my heartiest thanks to Mr. Sulit and to Dr. P. Valenzuela, executive secretary of the National Research Council, for their valuable help. Sulit(3) includes in his article the following statement with regard to the plant:

Phaeanthus ebracteolatus (Presl) Merr. Family Anonaceæ

Common names: Alatáuan, banátan, banitan, banitang, dalinas, kalimatás, katinau, lanótan, lanótang-itim, lanután, oyoi (Tag.); langlañgás, takulan (Ilk.); marasigiát (Gad.); puropugai (Neg.); yamban (Zbl.).

A small to medium-sized tree reaching a height of 6 to 8 meters and a diameter of 20 cm or more with an open crown and more or less horizontal branching. The bole is regular in shape, with dark-gray bark. When cut the color of inside bark is yellowish-cream, varying in thickness from 8 to 10 mm depending upon the size of the tree, fibrous and bitter in taste.

The leaves are alternate, subchartaceous, sparsely hairy beneath, oblong to oblanceolate, upon 5 to 10 mm long fulvous petioles, obtuse or bluntly acute, broadly obtuse to rounded at the base, 10 to 15 cm long by one-third as wide.

[1] This paper covers a part of the work carried out under the grant-in-aid of the National Research Council of the Philippines. Read before the Thirty-sixth Annual Meeting of the Philippine Islands Medical Association, Baguio, May 2–5, 1939.

The flowers are usually few from special numerously bracteate branches or stalks; pedicels 3 cm long, fulvous; calyx small, linearly dentate; petals 2 cm long, oblong, glabrate, leathery; torus 5 to 8 mm in diameter. The fruits are many, ellipsoid, averaging 1 cm long, glabrous, upon smooth stalks 2 to 3 times as long.

An endemic tree fairly well distributed from Babuyan Islands and Northern Luzon to Mindanao, in forests at low and medium altitudes.

The bark from younger trees is sometimes used for tying purposes. The same bark, after removing the outer portion, is scraped off into very thin pieces and put into a glass containing a small amount of clean water. The mixture is macerated and then filtered on a piece of clean cloth, and then dropped into sore eyes or inflamed conjunctiva before going to bed and in the morning, every day until the eyes are cured.

PREPARATION

Extract of the bark of *Phaeanthus ebracteolatus* has been shown to contain a large amount of alkaloids of two types, the tertiary and the quarternary alkaloids. A. C. Santos(1) and J. I. Sulit(3) have each separated a tertiary alkaloid; the former isolated cubical crystals and named them "phæanthine" and the latter, under the supervision of the former, isolated granular crystals to which the name "kalimatine" was given. After removal of these tertiary alkaloids, like the well-known strychnine, atropine, and others, by ether extraction in an alkaline medium, the aqueous portion left still contained a large amount of alkaloid or alkaloids. Alkaloids that could not be extracted by ether in alkaline medium are known as quarternary alkaloids. These quarternary alkaloids of *Phaeanthus ebracteolatus,* which have not yet been isolated in pure form but are present in aqueous or alcoholic solution, are the subject of the present paper.

The fluid extract of *Phaeanthus ebracteolatus* used in the experiments was prepared by percolation of the powdered bark No. 40 of *Phaeanthus ebracteolatus,* 4 parts of alcohol and 1 part of distilled water being used as menstruum. The powder was macerated for 2 days and then percolated at the rate of about 20 drops per minute, and after collecting 850 cc for every kilogram of powder used, the remaining percolate was separated and percolation continued until the percolate became negative to Mayer's precipitation test. The last percolate was then evaporated at low temperature and the residue added to the first collection and made up with menstruum to 1,000 cc for every kilogram of the powder that was employed. The fluid extract thus prepared is of a dark reddish-brown color, with a violet tint on the surface.

A standard quarternary alkaloidal solution or aqueous extract was prepared by taking a certain volume of the fluid extract, evaporating the alcohol, and removing the tertiary alkaloids in alkaline medium by the use of ether or chloroform, and the aqueous layer left, after having been rendered slightly acid to litmus paper, was made up to the original volume of the fluid extract taken. This was considered the standard quarternary alkaloidal solution of *Phaeanthus ebracteolatus*. Other aqueous extracts, not of standard strength, were also frequently employed. When the aqueous extract of kalimatas was reduced on spontaneous evaporation to semisolid consistency and the semisolid portion weighed and dissolved in water, the soluble or clear portions were designated of 2 per cent strength, if 2 grams of the semisolid extract was used in 100 cc of water. Two and 5 per cent of this type of preparation were employed in the experiments. The quarternary solution, in alkaline, neutral, or acid reaction, reacted with Mayer's reagent by producing precipitation. The alkaline solution was somewhat cloudy, dark brown, with a greenish tint on the surface; after acidification the color changed to clear red, or brownish red with a violet tint on the surface.

PHARMACODYNAMICS

Toxicity.—The pharmacodynamic effects of quartenary alkaloid in aqueous solution and of the fluid extract of *Phaeanthus ebracteolatus* have been found practically identical, so that a pharmacodynamic study of one preparation will represent the activity of the other. The minimum toxic doses were determined in different animals and in frogs representing cold-blooded animals; the minimum fatal dose was 0.5 cc of the fluid extract or of the standard quarternary alkaloidal solution per kilogram body weight, while in mammals, as represented by mice, cats, and dogs, the subcutaneous or intramuscular minimum fatal dose was 1 cc per kilogram body weight. The prominent symptoms with fatal doses were depression, as shown by sluggish movement, and inability to support the body, and then by preliminary increased respiration followed by decreased and difficult respiration until respiration ceased. In a similar way the heart beat faster and then slowed and stopped in all cases a few minutes after cessation of the respiration. An example of the effects on a dog of a maximum nonfatal dose of the extract of kalimatas, or *Phaeanthus ebracteolatus*, is shown in Table 1.

As shown in Table 1 the heart rate and respiratory rate were affected, being first increased and then decreased to a

TABLE 1.—*Effects on a dog of a maximum nonfatal dose of kalimatas extract.*

Time.	Pulse rate per minute.	Respiratory rate per minute.	Remarks.
9:55	100	22	Observation taken two times.
9:59	—	—	Injection into the gluteral region of 5 cc standard aqueous extract of kalimatas. Pain shown during injection.
10:09	116	36	Rubbing with mouth the place of injection.
10:20	124	28	Trembling of the legs.
10:30	142	26	Trembling of body and legs.
10:40	138	26	Lying on his abdomen. Would not stand on light stimulation.
10:50	136	26	Head drooping. Unwilling to stand.
11:00	134	24	Lying on the left side of hind body and on chest.
11:10	134	24	Lying on the left side of body and on chest. Pupils dilated.
11:20	128	20	Do.
11:30	134	16	Do.
11:40	134	18	Stood but soon laid down again.
11:50	136	16	Could not stand even after strong stimulation.
12:00	[a] 64	12	Expiration irregular and difficult. Much salivation.
12:10	46	12	Do.
12:20	[a] 68	14	Do.
12:40	104	18	Expiration slightly difficult and helped by jerky movements. Much salivation.
12:50	100	24	Regular respiration.
1:00	100	24	Do.
March 8	----------	----------	Strong, like normal.
March 9	----------	----------	Do.
March 10	----------	----------	Do.

[a] Irregular.

critical period when the dog seemed about to die, approximately about 2¼ hours after administration of the drug. The sudden change of the pulse rate occurred 2 hours after injection, when it decreased from 136 to 64 and then irregularly to 46, while respiration was difficult and expiration accompanied by jerky movements. Much saliva flowed from the mouth, and for about 40 minutes the dog was in serious condition, lying helpless, with jerky expiration; but soon thereafter the pulse improved and the respiration also increased, and 50 minutes after the onset of the critical condition the pulse rate and respiration became normal, the dog stirred and stood, weakly, especially on the hind legs. Thereafter he acted normal and continued to act normal during the 3 days of subsequent observation.

When the minimum fatal dose of 1 cc standard extract of kalimatas per kilogram body weight was injected in a 7-kilogram female dog, 7 cc in all being injected intramuscularly, the

animal died 28 minutes after injection, with cessation first of respiration and then of the heart. On autopsy the findings were: (*a*) collapsed lungs; (*b*) distended vena cava and right heart; (*c*) distended blood vessels of the mesentery, and (*d*) congestion of the liver.

Effect on blood pressure.—The most important effect of quarternary alkaloidal solution of *Phaeanthus ebracteolatus* or its fluid extract, observed on intravenous injection, was a fall in blood pressure. A distinct fall was produced with 0.1 cc and was correspondingly increased with increasing doses as indicated in tracings 1 to 5 (Plate 2). When the first dose was a large one, like 0.5 cc, and after recovery another injection was given of a diminishing dose, the subsequent diminishing doses produced a corresponding diminution in the blood-pressure falls. The same dose under similar conditions in the same animal produced practically identical falls of blood pressure, and this similarity in effects by equal doses was used as the basis for the employment of the blood-pressure method of assaying any of the alcoholic or aqueous preparations of the quarternary base of *Phaeanthus ebracteolatus*. In a series of animals the falls produced by the same dose of quarternary alkaloidal solution were different, more generally in smaller animals and where the initial blood pressure before injection was high. The recovery to normal blood pressure after each injection was slow and gradual, and the recovery was more gradual as the dose was increased. When a very large dose was administered, such as 1 cc of the fluid extract of the standard quarternary alkaloidal solution, the fall in blood pressure produced was so great as to reach nearly the base line. In tracing 6 (Plate 3) the systolic fall was from 142 mm Hg to 14 mm Hg. The respiration in tracing 7 (Plate 4) first accelerated and increased in amplitude, then decreased and finally stopped, and in tracing 6 a deep respiration was observed followed by irregularity and cessation, with the heart still beating for sometime. The blood pressure after cessation of respiration rose for a short time to fall again, or continued to fall until the heart ceased to beat, as shown in tracings 6 and 7. When artificial respiration was given, after cessations of respiration and contraction of the heart, recovery was observed to be difficult. However, when artificial respiration was given soon after respiration ceased, with the heart still beating, the heart continued to beat, maintaining the low-blood pressure for some time and gradually recovering, in one hour

or more, with the eventual restoration of respiration as shown in tracing 7.

The heart rate during the fall after intravenous injection of quarternary alkaloidal solution of *Phaeanthus ebracteolatus* either increased slightly or decreased after small doses and nearly always slightly decreased after large doses. The decrease was observed after small doses where the heart rate was fast previous to the injection and either distinctly increased or slightly decreased when the heart rate was slow previous to the injection. The heart contraction in intact animals during the fall after intravenous injection of quarternary alkaloidal solution of *Phaeanthus ebracteolatus* was greatly increased, as shown in the cardioplethysmograph tracing 8 (Plate 5).

The intestinal volume during the fall first increased, and then decreased while the blood pressure was returning to normal. On the other hand, the kidney volume seemed to follow the blood-pressure effects, first falling and then rising, with definite relation to the fall and then gradual rise of the blood pressure after injection of the quarternary alkaloidal solution of *Phaeanthus ebracteolatus.* The preceding effects were generally obtained in dogs with low blood pressure due to the use of morphine as general anæsthetic. However, when the blood pressure was previously raised by injecting curare to paralyze the muscles and then a toxic or convulsive dose of strychnine, the effects of the aqueous extract of kalimatas on intestinal and kidney volumes were greatly increased as shown in tracing 9 (Plate 6).

The fall of blood pressure produced by quarternary alkaloidal solution of *Phaeanthus ebracteolatus* on a dog with cut vagus nerves was almost as much as with intact vagus nerves. The fall was not prevented by previous administration of atropine.

Comparison with nitroglycerin and acetylcholine.—With a 2 per cent solution of acetylcholine chlorate and beginning with a small dose, like 0.05 cc, injected intravenously, the fall of blood pressure produced was sudden, as shown in tracing 10 (Plate 7). If after administration of atropine the same dose was repeated or twice as large a dose given, as shown in the tracing, the typical fall was not obtained, but instead the blood pressure rose and remained high for some time. On the other hand, intravenous injection of the quarternary alkaloidal solution of *Phaeanthus ebracteolatus,* after application of atropine, produced the characteristic fall of blood pressure shown in the same tracing 10. Repetition of injection of acetylcholine and quarter-

nary solution, with the dog still under the influence of atropine, produced similar effects, rise with acetylcholine and fall with quarternary alkaloids of *Phaeanthus ebracteolatus*.

The fall in blood pressure produced by quarternary alkaloidal solution of *Phaeanthus ebracteolatus* was in some points different from that produced by nitroglycerin. Tracings 11 and 12 (Plate 8) show the effects of nitroglycerin and of the quarternary alkaloidal solution, respectively. With doses which produced an almost identical fall in blood pressure or even a greater fall in the case of nitroglycerin, the recovery was gradual in the case of the quarternary alkaloidal solution and rather rapid after nitroglycerin. This difference has been observed to remain constant in several experiments. Other differences are in the heart rate during the fall and in the effects on the intestinal volume. While the heart rate during the blood-pressure fall after nitroglycerin was greatly increased in the case of quarternary alkaloidal solution, the majority of the cases showed slight slowing down, no change, or a slight increase; but the increase, if there was any, was not as marked as in the case of nitroglycerin. The effects on the intestinal volume showed greater increase or rise in the record after injection of nitroglycerin than that produced by injection of kalimatas.

OTHER PHARMACODYNAMIC EFFECTS

In a perfusion experiment on a separated leg of a dog, where the flow was made slow by either injection of epinephrine or pitressin, injection of quarternary alakaloidal solution of *Phaeanthus ebracteolatus* caused a sudden increase in the flow.

An excised heart of frog, prepared by Straub-Fuehner's(2) method, showed, after addition of a trace of the quarternary alkaloidal solution of *Phaeanthus ebracteolatus*, a slight increase in the amplitude of contraction as shown in tracing 13 (Plate 9). In tracings 14 and 15 of the same plate the response to ½ drop of the quarternary alakaloidal solution was always decreased in the amplitude of contraction. When 1 drop was employed, the heart contraction diminished and ceased after some time, but was again revived by a change of the Ringer solution, as showing in tracing 6.

The natural movement of an excised intestine from a cat suspended in aërated Locke-Ringer solution, and kept warm at 37° to 38°C., was decreased or stopped by addition of quarternary alkaloidal solution as shown in tracing 17 (Plate 10).

In the tracing the intestinal contraction was resumed immediately after addition of pilocarpine. In a similar way the movement of the excised intestine, augmented by pilocarpine, was stopped by addition of quarternary alkaloidal solution as shown in tracing 18 (Plate 10). In tracing 19 (Plate 10) the intestinal contraction was diminished by addition of aqueous extract of kalimatas and stopped by further addition of another dose, made to contract by addition of barium chloride, and again relaxed by addition of a large dose of kalimatas solution. It will be noticed in the experiments that relatively large doses were necessary to produce a decided effect of depression on the intestinal movement, especially when this was previously stimulated by pilocarpine or barium.

In a similar way, experiments were carried out by suspending an excised tracheal muscle from a dog in Locke-Ringer solution, aërated and kept at a temperature of 37° to 38°C. The results are shown in tracings 20 and 21 (Plate 11). The tracheal muscle was made to contract by addition of pilocarpine in one and barium in the other. Tracing 20 shows the stimulant effect of pilocarpine hydrochloride on an excised tracheal muscle, counteracted by aqueous extract of *Phaeanthus ebracteolatus*. Ordinarily, without addition of another drug, after reaching the peak of maximum contraction produced by pilocarpine, the muscle began to relax gradually and then remained contracted to the same degree or was even contracted more, so that the record will show an abrupt rise followed by a gradual fall to a uniform level, and another slight rise after about 20 to 30 minutes. The fall never reached one half but generally reached a third or less of the maximum height of contraction. In the experiment the addition of 2 cc of standard quartenary alkaloidal solution of *Phaeanthus ebracteolatus* caused a distinct fall in the record or a relaxation of the muscle, but the depressant action was not sufficient to produce a complete relaxation. In a similar way the effect of depression, as shown in tracing 21, with 2 cc of standard quarternary alkaloidal solution on excised tracheal muscle made to contract by barium chloride, was not sufficient to relax the muscle completely.

The effect of quaternary alkaloidal solution on the contraction of an excised uterus from a cat suspended in Locke-Ringer solution, aërated and kept at a temperature of 37° to 38°C., is shown in tracings 22 and 23 (Plate 12). In both tracings the uterine contraction was augmented by addition of pitocin in one and his-

tamine in the other. During the height of contraction solution of quarternary alkaloids of *Phaeanthus ebracteolatus* was added in each case, and distinct relaxation was obtained in both.

Application of one or two drops of quarternary alkaloidal solution on the eye of a cat or a dog produced slight reddening of the conjunctiva with no change in the size of the pupil. The reddening disappeared in about 12 minutes after application of one drop and in about 20 minutes after 2 drops.

DISCUSSION

The fall of blood pressure produced by any drug is occasioned either by dilatation of the blood vessels, especially of the splanchnic region, or by decreased output of the heart due to vagus stimulation or direct depression of the heart itself, or by both. Vagus stimulation was not concerned in the fall of blood pressure produced by quarternary alkaloidal solution of *Phaeanthus ebracteolatus,* for the same effect was produced after cutting the vagus nerves or after paralysis of the vagus receptive mechanism by atropine. Direct depression of the heart alone could not explain the falls in blood pressure, for with small doses the heart contraction was even increased in rate and amplitude, while with large doses slight slowing and distinct diminution of the heart contraction were produced. In view of this, the fall in blood pressure produced by small doses of quarternary alkaloidal solution could be explained by dilatation of the blood vessels, while after moderate and large doses the fall was brought about by dilatation of the blood vessels and depression of the heart. The dilatation of the blood vessels was confirmed by increase in the organ volume of the intestine during the fall of blood pressure and increase in the amount of flow in the perfusion experiment. The action of a drug in dilating the blood vessels may be due to either direct depression of the muscles, to a certain action of the drug on the nerves, or to a combination of the two; but since the quarternary alkaloidal solution relaxed all smooth muscles, irrespective of their innervation, it may be concluded that the dilating effect of quarternary alkaloidal solution of *Phaeanthus ebracteolatus* was due to depression of the smooth muscles of the blood vessels.

CONCLUSIONS

1. The quarternary alkaloid in aqueous or alcoholic solution of *Phaeanthus ebracteolatus* depresses the smooth muscles, espe-

cially of the blood vessels, and as a result the blood pressure falls. With moderate and large doses the fall in blood pressure produced by quarternary alkaloids of *Phaeanthus ebracteolatus* may be partly due also to depression of the heart.

2. With sufficient large doses it also depresses the intestine, tracheal muscles, and uterus, and is able to counteract the stimulant effects produced by pilocarpine and barium on the intestine and tracheal muscles, and by pitocin and histamine on the excised uterus.

3. The fall in blood pressure produced by quarternary alkaloids of kalimatas was of longer duration than that produced by nitroglycerin and acetylcholine, two well-known drugs that lower the blood pressure.

4. With fatal doses the respiration was first increased temporarily then decreased and stopped. The blood pressure fell to as low as 14 mm or less of Hg and kept at that level until it was raised by asphyxia, and then dropped to zero level through cessation of the heart beat a few minutes after the failure of respiration. When artificial respiration was applied after cessation of respiration, the heart continued to beat, maintaining the low blood pressure for some time, and then gradually recovered to normal inside of 1 hour or more after administration of the drug.

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ILLUSTRATIONS

[Illustrations prepared for publication by Francisco Rafael.]

PLATE 1

Close view of trunk of *Phaeanthus ebracteolatus.*

PLATE 2

Tracings 1 to 5 of blood-pressure falls after intravenous injection of fluid extract of *Phaeanthus ebracteolatus* on a 10.5-kilogram female dog under morphine, 15 mg per kilogram body weight, and ether during operation. Tracing *1*, 0.1 cc injection; *2*, 0.2 cc injection; *3*, 0.3 cc injection; *4*, 0.4 cc injection; *5*, 0.5 cc injection. Intervals on scale are equal to 6 seconds.

PLATE 3

Tracing 6, respiration and carotid blood pressure of a 7.4-kilogram female dog, under morphine sulfate, 15 mg per kilogram body weight, and ether during operation. Intervals on scale are equal to 6 seconds.

PLATE 4

Tracing 7, respiration and carotid blood pressure after intravenous injection of 1 cc of quarternary alkaloids (1:1 solution) of *Phaeanthus ebracteolatus.* Intervals on scale are equal to 6 seconds.

PLATE 5

Tracing 8, heart contraction and blood pressure. Intervals on scale are equal to 6 seconds.

PLATE 6

Tracing 9, intestinal volume, blood pressure, and kidney volume of a 10.3-kilogram female dog under morphine sulfate curare, and strychnine sulfate.

PLATE 7

Tracing 10, quarternary solution of *Phaeanthus ebracteolatus* compared with acetylcholine. Intervals on the scale are equal to 6 seconds.

PLATE 8

Tracings 11 and 12, blood pressure falls produced by quarternary solution of *Phaeanthus ebracteolatus* and by nitroglycerin. Intervals on scale are equal to 6 seconds.

PLATE 9

Tracings 13 to 16, effect of quarternary alkaloidal solution on contractions of an excised frog's heart.

PLATE 10

Tracings 17 to 19, effect of addition of kalimatas extract to excised cat's intestine in Locke-Ringer solution. Intervals on scale are equal to 6 seconds.

PLATE 11

Tracings 20 and 21, effect of pilocarpine HCl, barium chloride, and standard quarternary alkaloidal solution of *Phaeanthus ebracteolatus* on an excised tracheal muscle in 200 cc Locke-Ringer solution. Intervals on scale are equal to 6 seconds.

PLATE 12

Tracings 22 and 23, effect of pitocin, kalimatas extract, adrenaline, pitressin, and histamine on an excised cat's uterus (nonpregnant) in 200 cc Locke-Ringer solution. Intervals on scale are equal to 5 seconds.

PLATE 1.

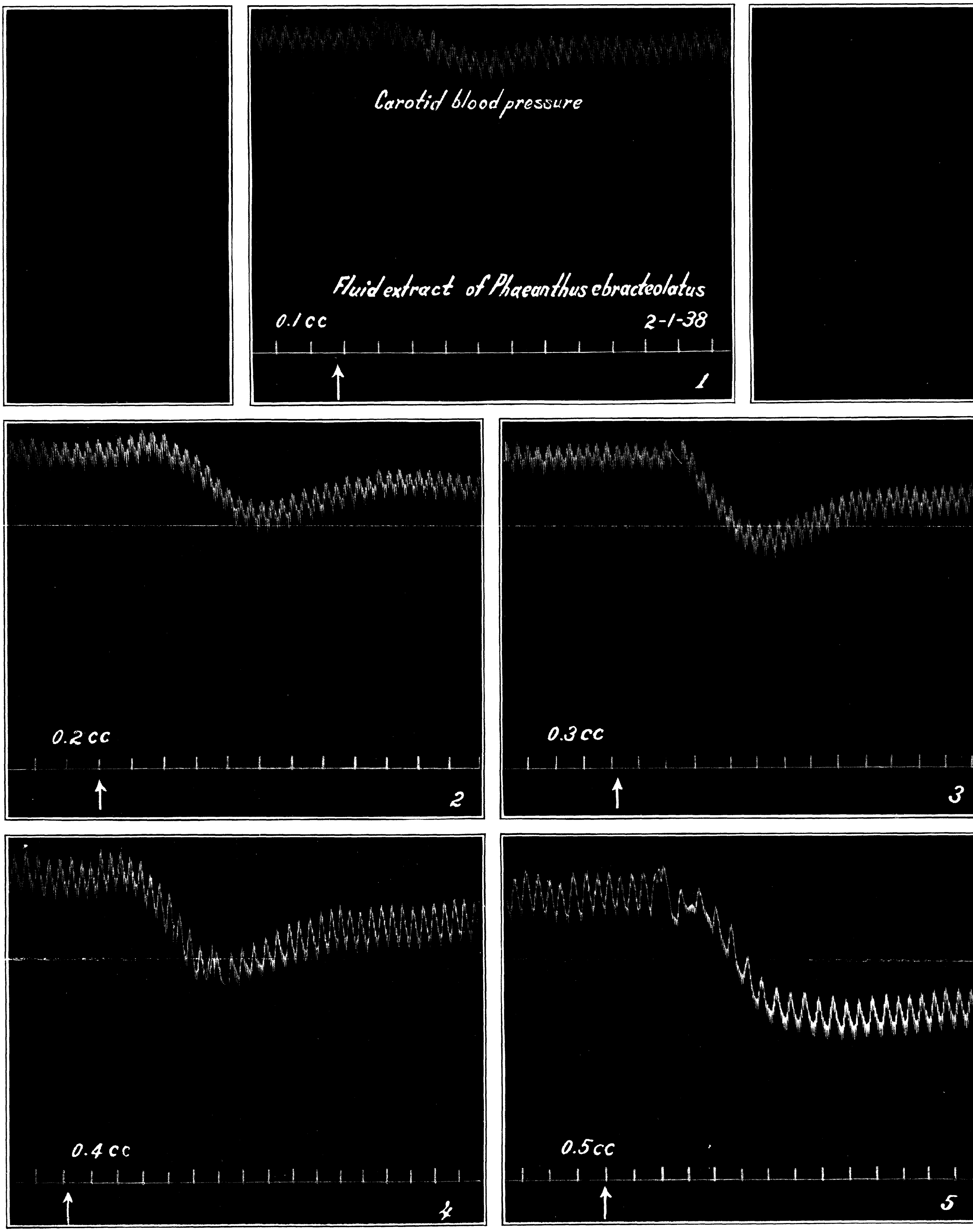


PLATE 2. TRACINGS 1 TO 5.

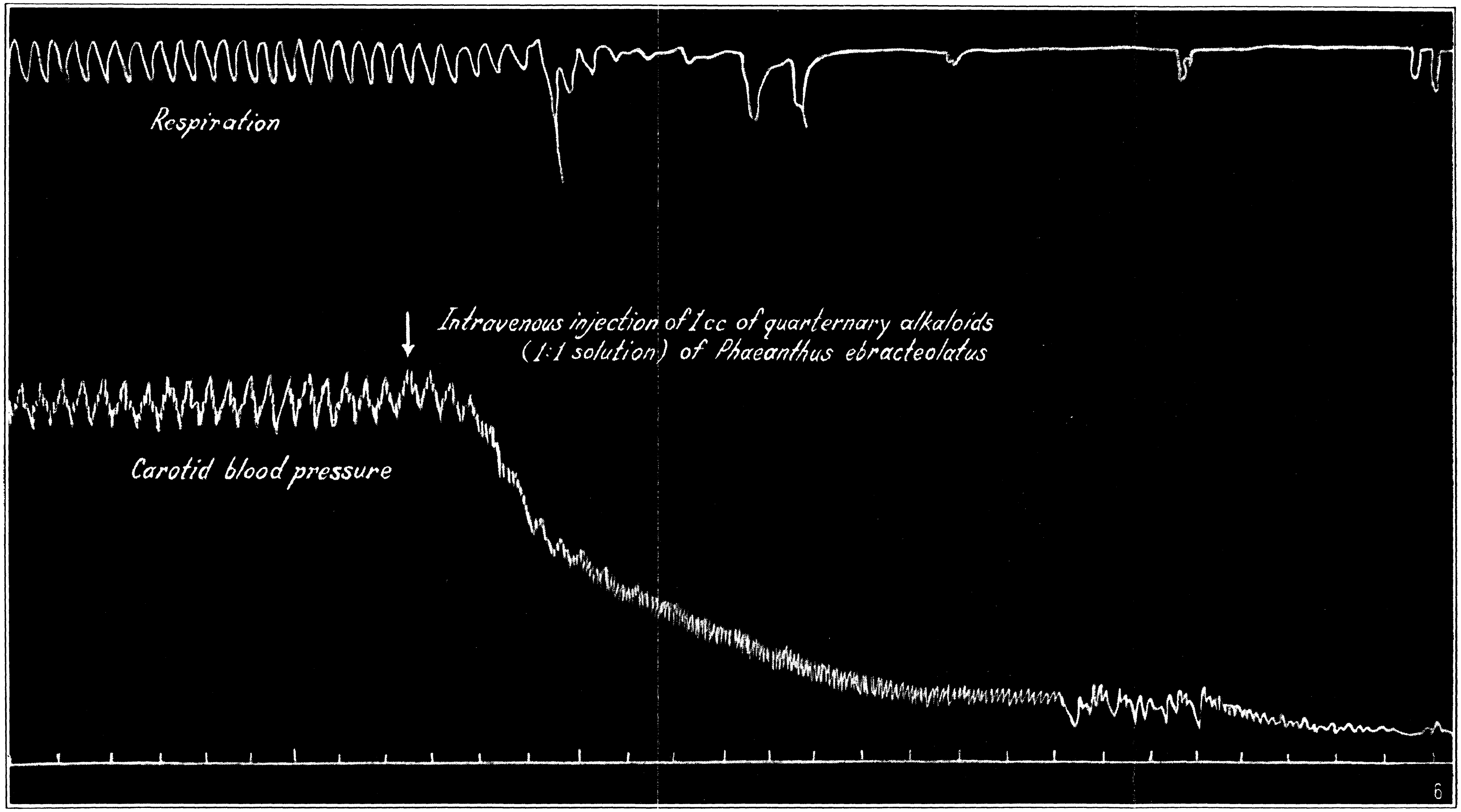


PLATE 3. TRACING 6.

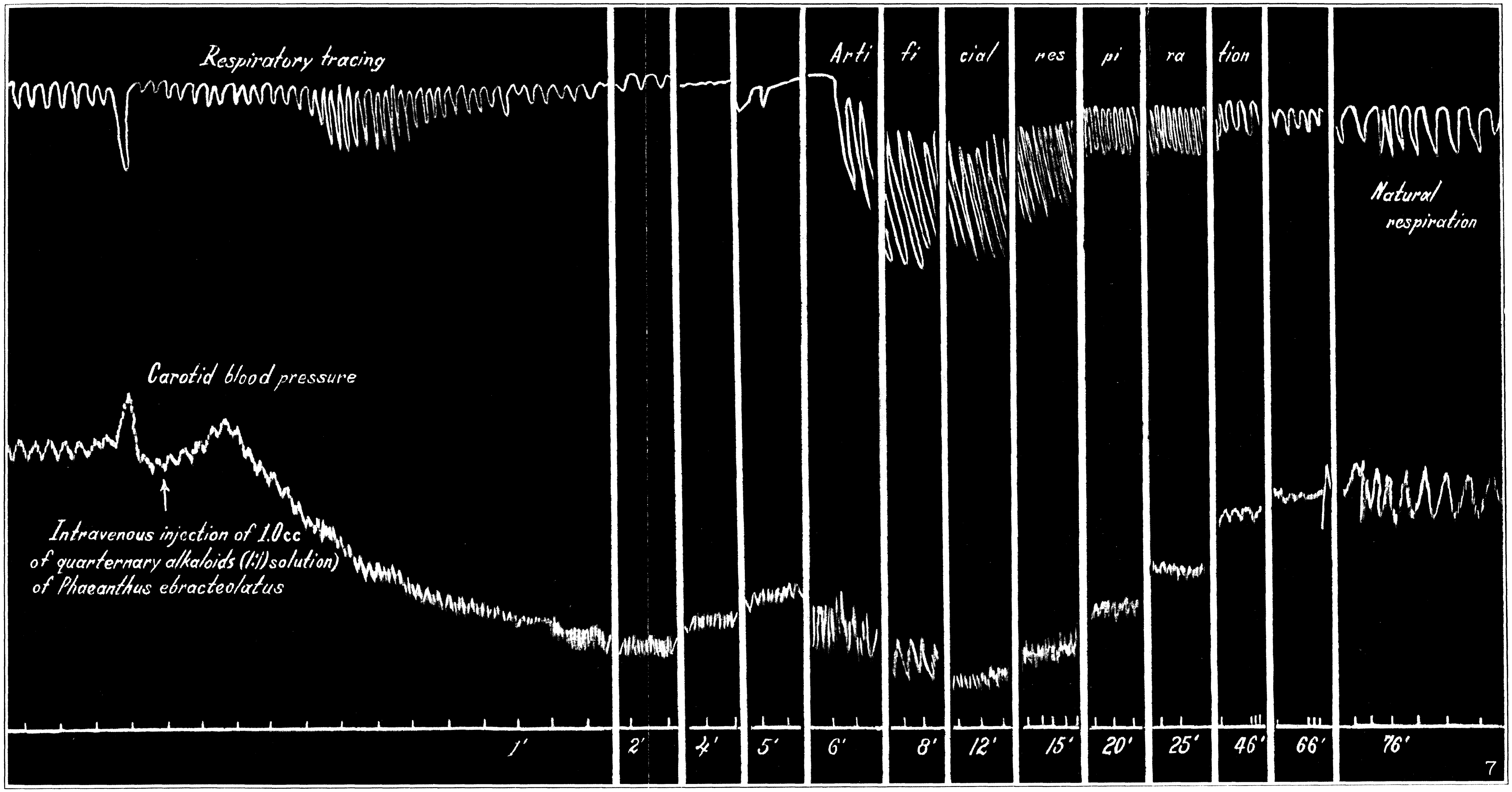


PLATE 4. TRACING 7.

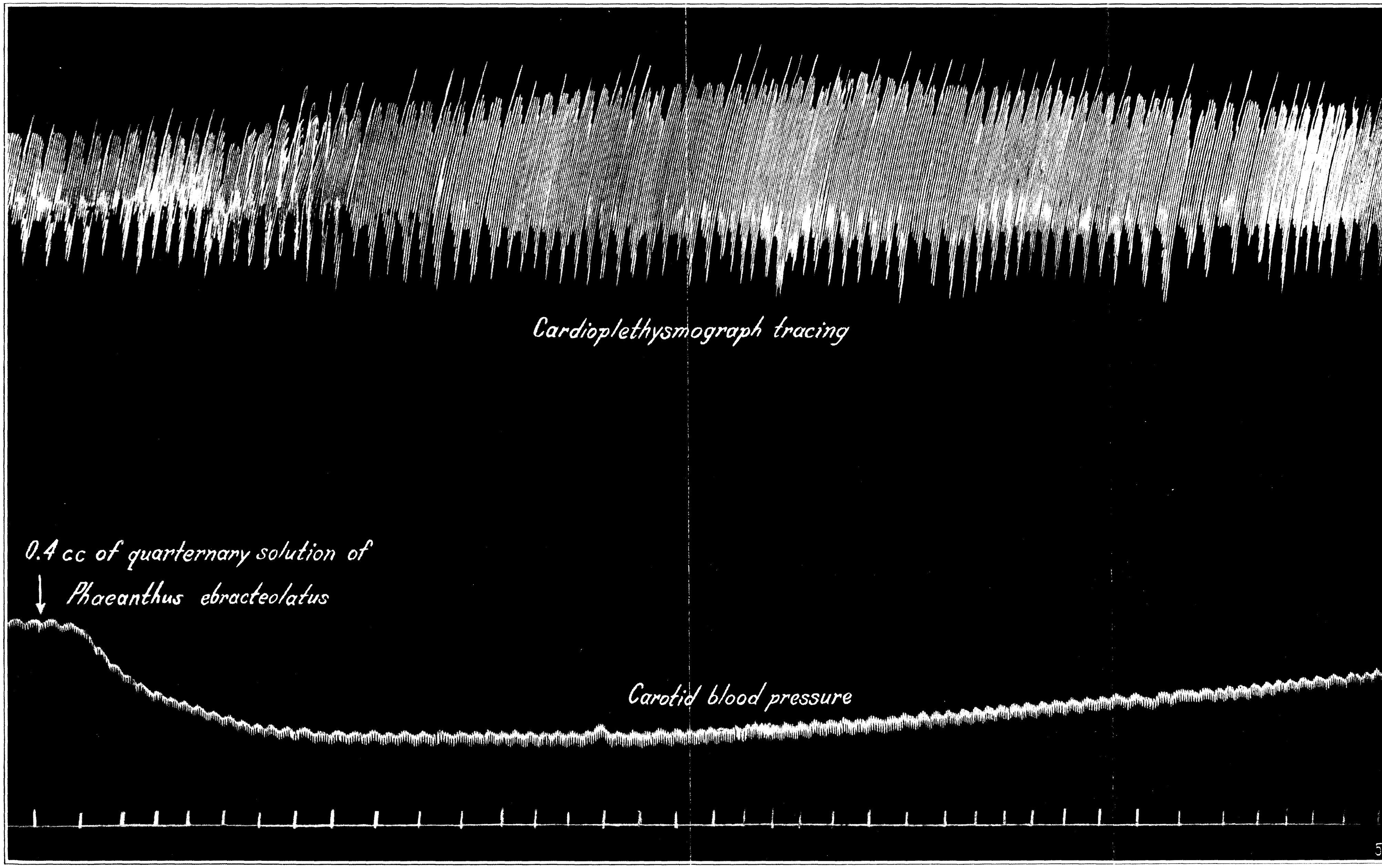
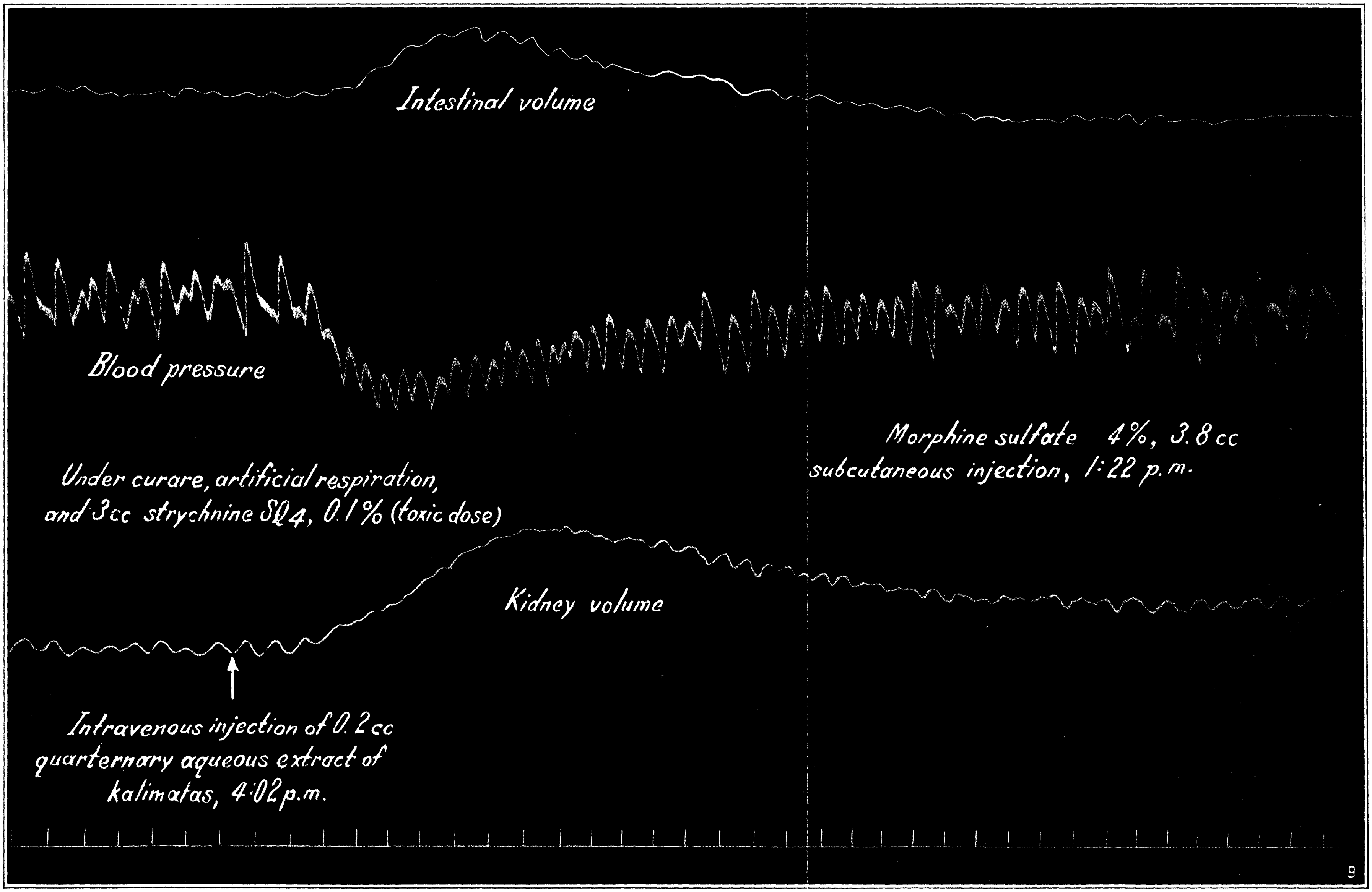


PLATE 5. TRACING 8.



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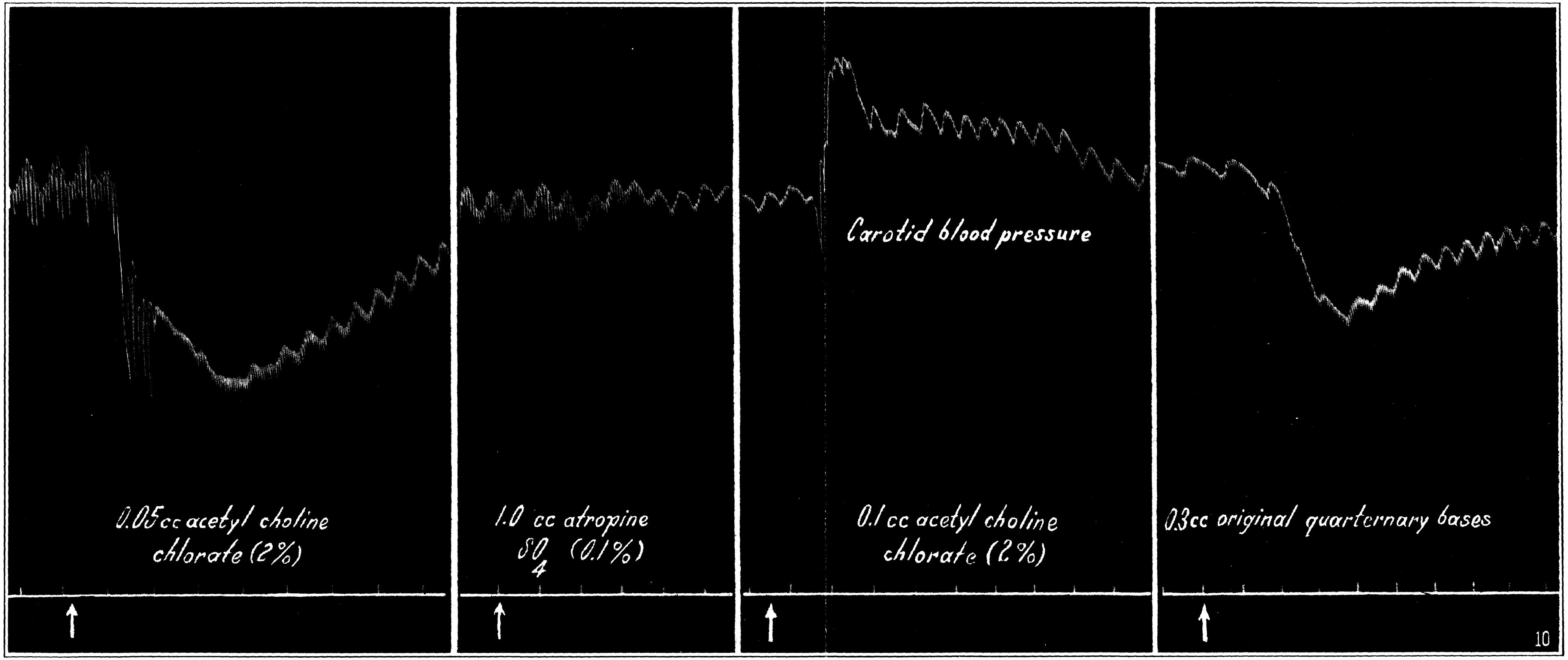

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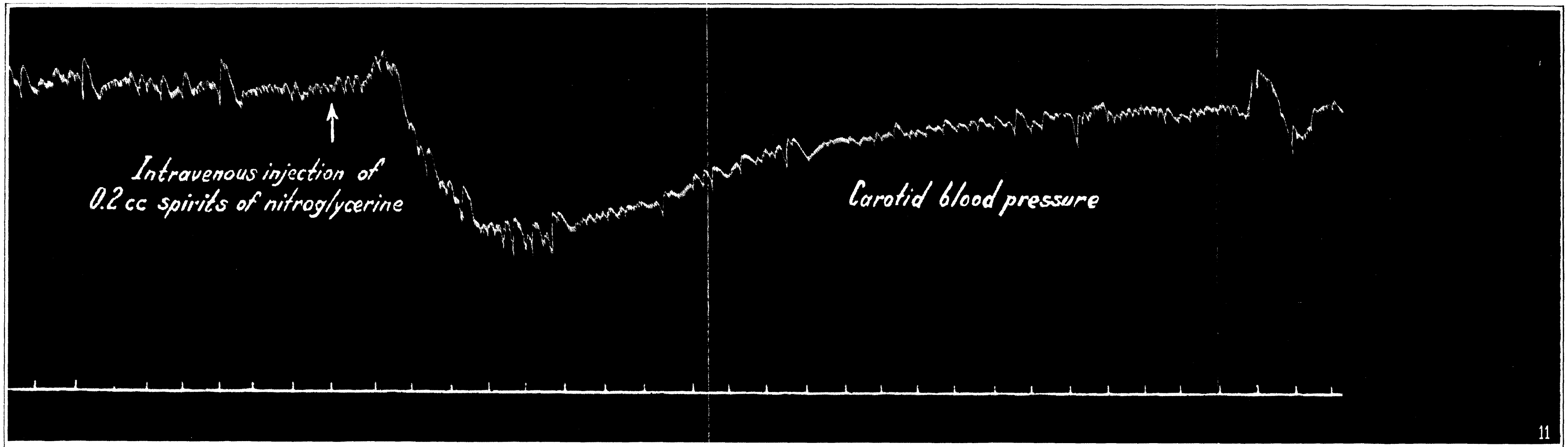

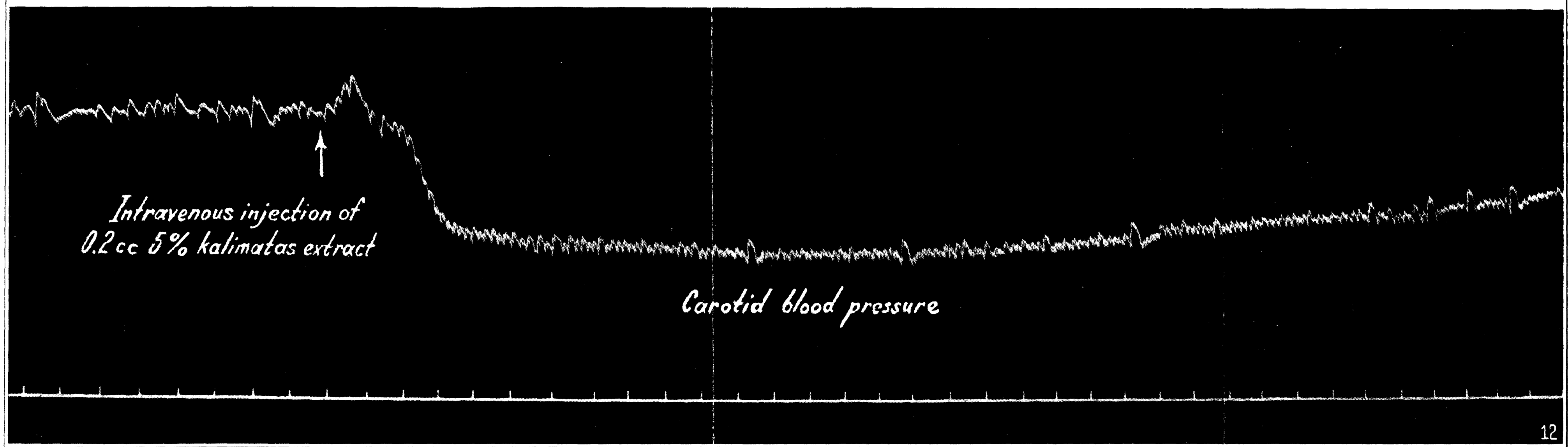

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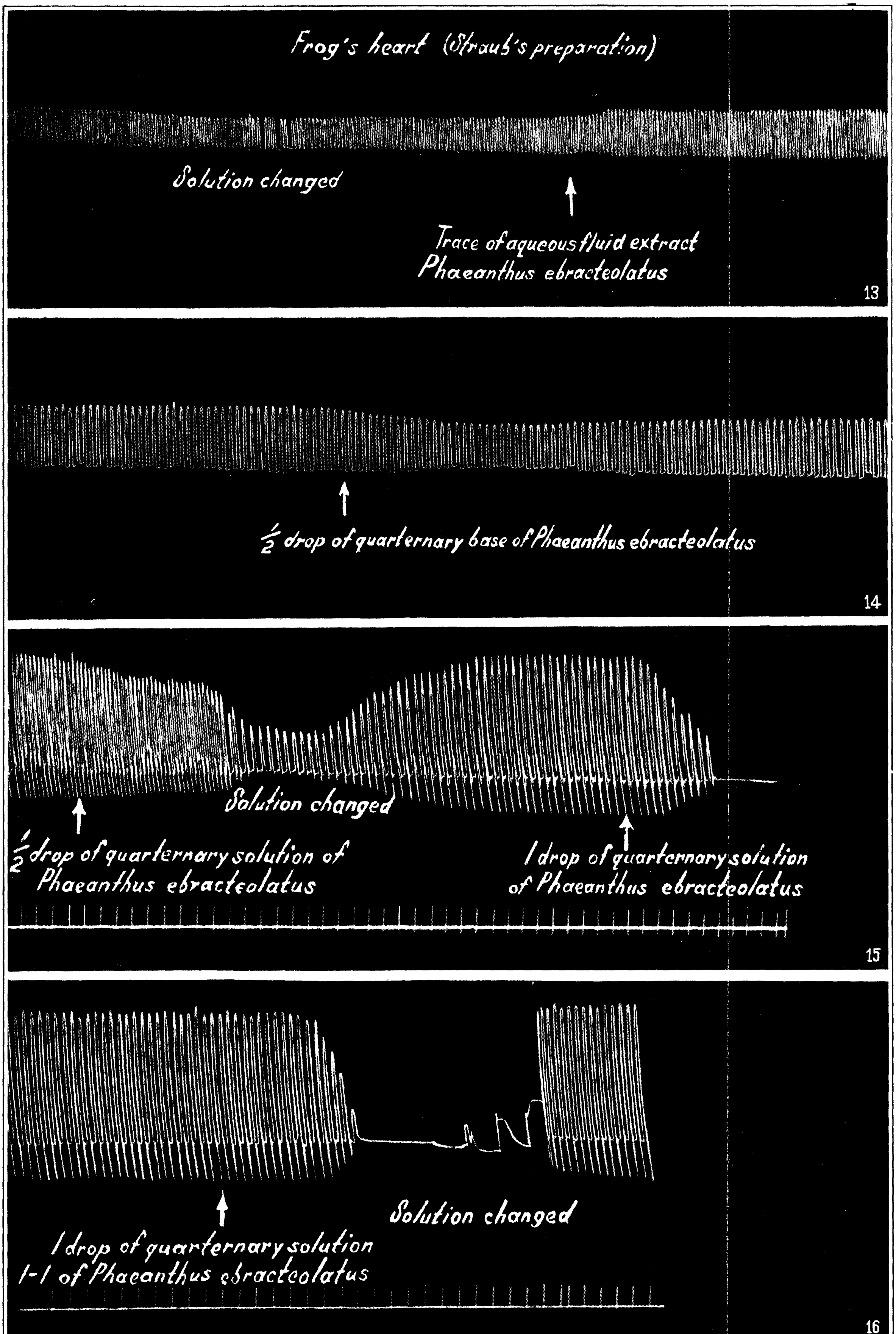

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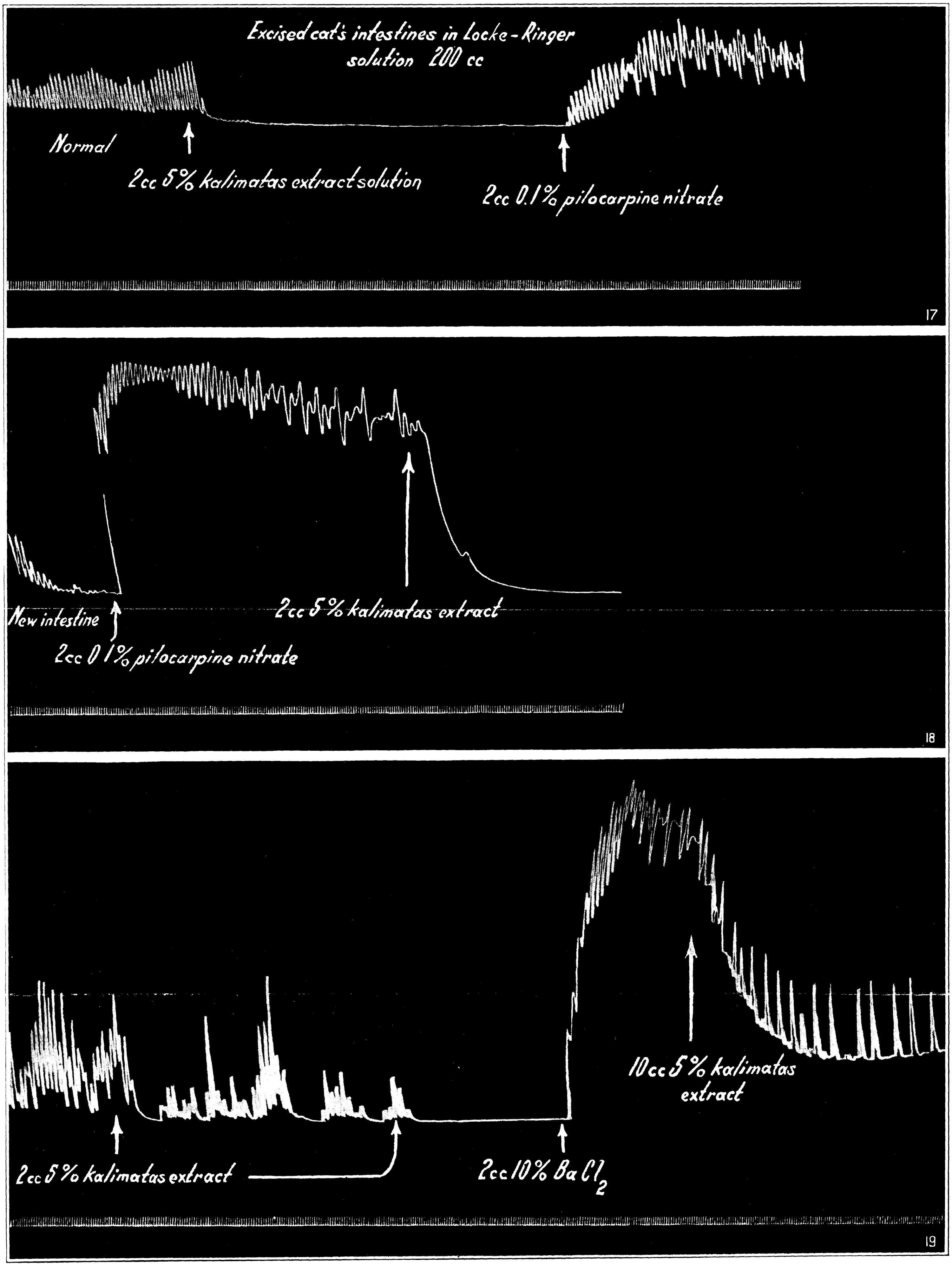

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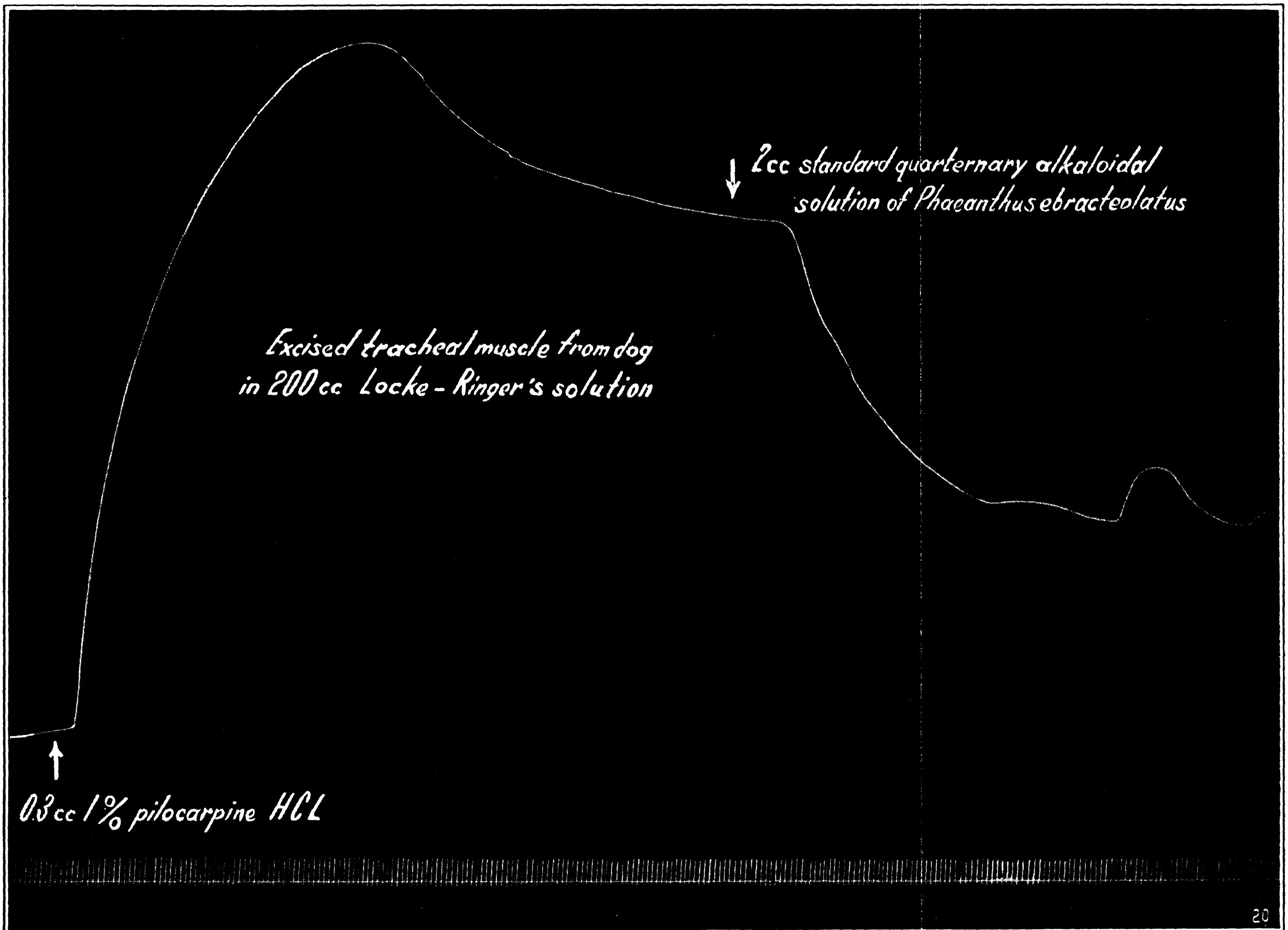


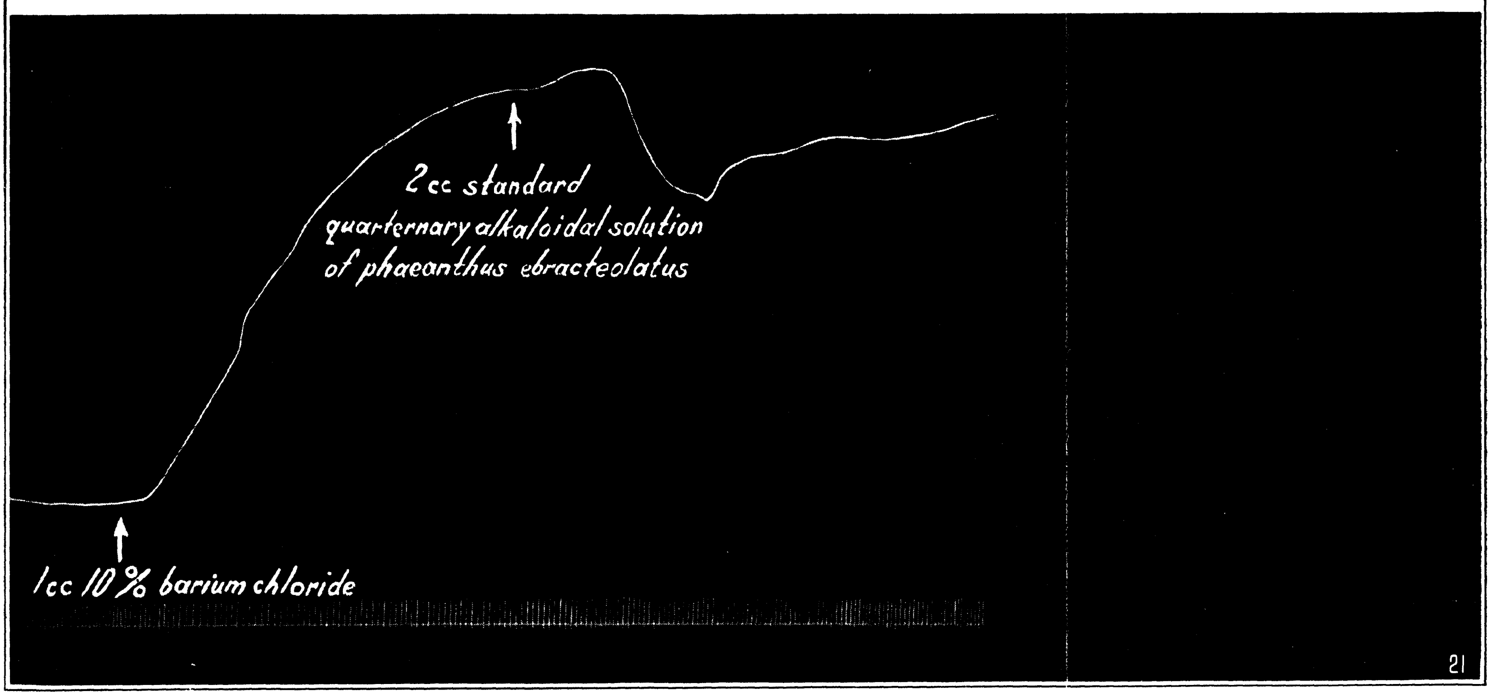
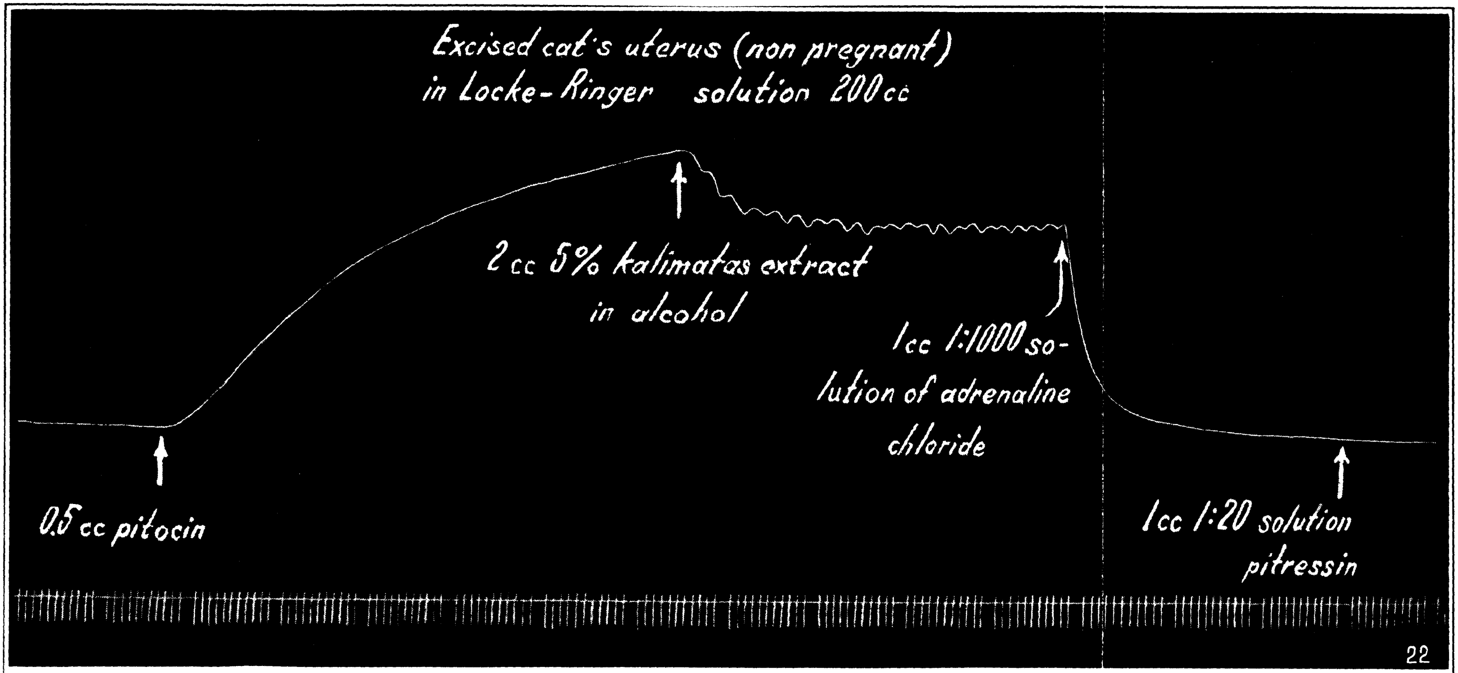


PLATE 11. TRACINGS 20 AND 21.



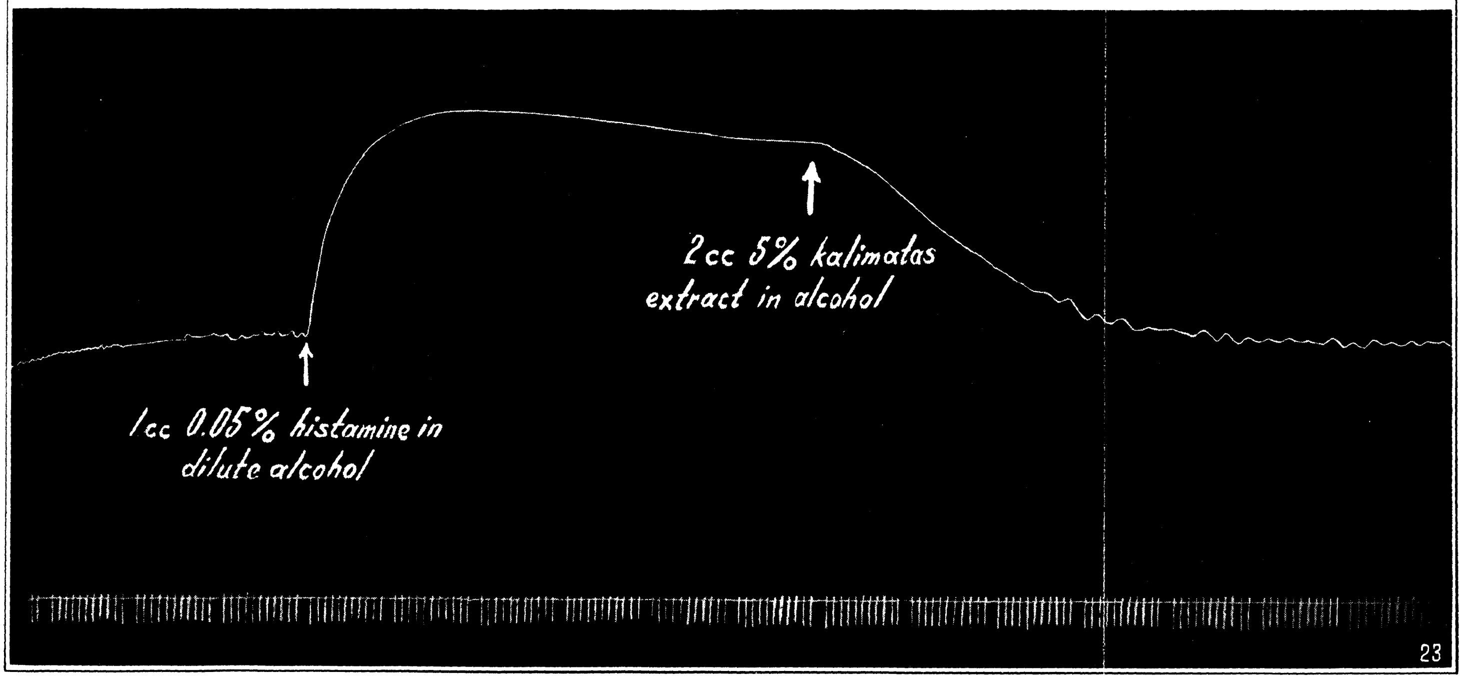


PLATE 12. TRACINGS 22 AND 23.

TWO NEW PHILIPPINE GOBIOIDS

By GUILLERMO L. ABLAN

Of the Division of Fisheries, Department of Agriculture and Commerce Manila

TWO PLATES

In my recent collection of fish in Dagupan, Pangasinan Province, I have had occasion to examine two gobioid specimens of the genera *Apocryptodon* and *Lophogobius,* which are apparently new. The original descriptions of these two genera are included in this short paper, with a discussion of the relationship of the genus *Lophogobius* to the genus *Cristatogobius.*(1)

Genus APOCRYPTODON Bleeker

Apocryptodon BLEEKER, Esquisse Arch. Neerl. sc. ex. et nat. 9 (1874) 327 (*Apocryptes madurensis* Blkr.).

Body very elongate, anteriorly subcylindrical, posteriorly compressed, covered with 40 to 60 deciduous cycloid scales. Head posteriorly subcylindrical, anteriorly a little depressed, scaled above behind eyes, laterally scaled from under eye on preoperculum and operculum. Eyes in anterior half of head, bony interorbital less than 1 diameter of eye. Snout a little more than 1 diameter of eye. Nostrils not tubular. Mouth nearly horizontal, jaws subequal. Teeth in both jaws in one row, in upper jaw caninoid, in lower jaw horizontal, truncate to bilobate, after symphysis on each side a canine. The upper jaw has a curvity, receiving the tip of the lower jaw. Tongue rounded, nearly totally adnate to the floor of the mouth. Gill openings about as long as breadth of base of pectoral fin, isthmus broad. Inner edge of shoulder girdle without fleshy flaps. Dorsal fins close together, first dorsal with 6 spines; second dorsal with 23 to 24 rays; anal with 22 or 23 rays; ventrals united, oblong under pectorals. Pectorals without free rays, base scaled; caudal pointed.

APOCRYPTODON LOMBOYI sp. nov. Plate 1.

First dorsal VI; second dorsal I, 20 or 21; anal I, 20 or 21.

Head low, elongate, little broader than body, 4 to 4.4 times in length and slightly greater than caudal; snout slightly convex, with a fleshy fold above upper jaw, 5 to 6 times from tip of

snout to origin of first dorsal; mouth large and oblique, lower jaw a little less than upper jaw; posterior angle of maxillary extending beyond posterior margin of eye; eyes small, dorsolateral, upward gazing, close together, equal to orbital space; a median terminal hump on snout before eyes; upper jaw with 16 to 22 teeth, anterior teeth generally long and curving inwardly over lower jaw; 18 to 26 bifid teeth outwardly inclined and not extending as far back as teeth of lower jaw; few round and small dusky spots on side of head from gill opening to an angle below eye; scales on opercle small and bluish, concolorous to belly.

Body subcylindrical, low and elongate, very little elevated and almost parallel to ventral profile; 8 or 9 dusky blotches saddle dorsal side from head to caudal; another series of 5 or 6 blotches in middle portion of body; 58 to 60 scales in longitudinal series, 15 to 18 in transverse series, and 27 to 30 before first dorsal.

Pectoral fins broad and pointed, 2.3 to 3 times in base of anal, longest rays extending back at an angle below base of fifth spine or first blotch in the side; base of pectoral naked, mottled with fine round specks, lower edge of pectoral fin dusky with a narrow grayish outline; first dorsal higher than second, last or sixth spine, placed very far from fifth, scarcely reaching origin of second dorsal when depressed; second dorsal and anal alike in shape, low, reaching base of elongate, pointed caudal when depressed; ventrals either oblong or elongate, under pectoral; color not much changed in spirit after several days, grayish and freckled with blackish specks or dots all over body and head; scales easily dislodged in living specimens.

The present new species shows overlapping characters with the other species so far known locally. It is very close to *A. sealei* and *A. montalbani* in having blotches in the middle of the side of the body, but very distinct from anyone of them in having prominent blotches saddling the dorsal.

Table 1 shows comparison of the dentition, scale count, fin rays, and number of specimens on which the original description is based, for every Philippine species of the genus.

Here described from 27 specimens, the type, No. 31128, and 26 cotypes, 50 to 65 millimeters long, obtained from fish vendors in Dagupan, Pangasinan Province, Luzon. The specimens are kept in the ichthyological collection of the Division of Fisheries,[1] Department of Agriculture and Commerce, Manila.

[1] Formerly the Fish and Game Administration, Bureau of Science, Manila.

TABLE 1.—*Dentition, scale count, and fin rays of Philippine species of Apocryptodon.*

Apocryptodon.	Specimens.	Dentition.		Scale count.			Fin rays.	
		Upper.	Lower.	Long.	Trans.	Predors.	Dorsal.	Anal.
lomboyi	27	16–22	18–26	58–60	15–18	27–30	VI, I,20 I,21	I,20 I,21
montalbani	1	24	24	56	16	24	VI, I,21	I,21
sealei	1	20	28	52	18	22	VI, I,21	I,22
taylori	1	18–20	16	60	--------	34	VI, I,22	I,21

This species is named for Julian S. Lomboy, an artist, for his patience in sketching this fish.

DISCUSSION OF THE GENERA LOPHOGOBIUS GILL AND CRISTATOGOBIUS HERRE

The genus *Lophogobius* (Gill, 1862), which was established from the type, *Gobius crista-galli* Cuv. & Val., is represented by species inhabiting the West Indies and Florida.(1) The genus *Cristatogobius* Herre was established from 3 specimens of the type *C. lophius*. Koumans,(2) in his preliminary revision of the genera of gobioid fishes with united ventral fins, claims that *Cristatogobius* Herre is closely allied to *Lophogobius* Gill, confirming a similar remark of Herre in the original description of *Cristatogobius*.

In the original description of *Cristatogobius*, Herre mentions a single row of teeth in *Lophogobius*, a character of dental variation that warrants establishing *Cristatogobius* as a new and separate genus, having 4 rows of teeth. Koumans saw in the specimens of *Gobius crista-galli*, the type of *Lophogobius*, that the teeth were placed in several rows, the outer row being enlarged, and lacked canines. Thus, while *Cristatogobius* and *Lophogobius* have teeth in rows, *Cristatogobius* differs from *Lophogobius* in having a pointed caudal and canines.

Genus LOPHOGOBIUS Gill

Lophogobius GILL, Proc. Acad. Nat. Sci. Phila. 14 (1862) 240 (*Gobius crista-galli* Cuv. & Val.).

Body elongate, compressed, covered with 25 to 30 scales, ctenoid on most parts of body, becoming more cycloid on nape, breast, and belly. Head compressed, with swollen cheeks, naked. Nape with fleshy, naked crest, scales on nape beginning from a vertical from posterior margin of preoperculum, eyes in ante-

rior half of head, bony interorbital and snout about 1 diameter of eye. Snout blunt. Anterior nostril in a short tube. Mouth oblique, lips thick, jaws subequal. Teeth in both jaws in several rows, outer row a little enlarged, canines lacking. Tongue rounded. Some mucous canals diverging under eye and some short canals around eye, some on operculum, a longitudinal one on preoperculum, and one along lower jaw to posterior margin of preoperculum. Open pores, one median of posterior nostril, one in interorbital space close before beginning of nuchal crest, one after each eye, some along upper and posterior margins of preoperculum. Gill openings as long as breadth of base of pectoral fin, isthmus broad. Inner edge of shoulder girdle without fleshy flaps. Dorsal fins separate, first dorsal with 6 spines, second dorsal and anal with 7 to 10 rays, ventrals united, oblong, under pectorals. These without free silklike rays; caudal rounded.

LOPHOGOBIUS NONATOÆ sp. nov. Plate 2.

First dorsal VI; second dorsal I, 9, rarely I, 10; anal I, 9.

Head a little deeper than body, 3.1 to 4 times in length, dorsal profile above eyes forming a curve to origin of dorsal, snout short and slightly convex, equal to eye, eyes forming a linear interorbital space; posteriad of eyes on nape a skinny crest or comb extending back to first dorsal, and with a base equal to or less than body in depth; mouth almost vertical and with a projecting chin; posterior angle of maxillary in line with anterior of eye or a little over; nape with small scales; rows of mucous canals on head; two behind eyes on nape, one double horseshoe- or S-curved below eye on preopercle, some on operculum, around eye, one on lower edge of chin; teeth in several rows in each jaw, those of outer and inner rows enlarged, posterior lateral pair of large backward-curved canines in outer row of lower jaw, tongue rounded at tip.

Body compressed laterally, scales larger posteriorly from first dorsal to caudal, 31 to 33 in longitudinal series, 11 in transverse series; all fins except pectoral dusky, in life grayish with green specks in yellowish shade on cheeks, becoming prominent on sides above pectorals, assuming rod-shaped blotches; reddish streaks on base of pectoral, anteriad of caudal a number of round specks of similar tinge as that

above pectorals; spinous dorsal with flexible spines, third and fourth longest, longest spine in line with upper margin of base of pectoral, its base 2 times longest spine; second dorsal and anal similar in shape, anal a little lower in height, their longest rays reaching caudal when depressed; in life second dorsal cross-barred with reddish bars in four rows; first dorsal with greenish specks; pectoral long and pointed, its long rays extending at a point below second ray of second dorsal, 2 to 2.8 times body; caudal pointed and longer than head; ventrals originating below pectorals and extending as far as anal papillæ; in alcohol or spirit slatey blue, specks on body becoming white dots.

The present species is very close to *Cristatogobius lophius* and *Gobius crista-galli* in having teeth in several rows, and in the presence of mucous canals and pores on the head. It resembles *C. lophius* and differs from *Gobius crista-galli* in having a pointed caudal. It is very distinct from *C. lophius* in the absence of crossbands on the sides, in having fewer rays in the second dorsal and anal, and in the greater number of scales in longitudinal and transverse series.

Here described from type specimen No. 31129 and 49 cotypes, 18 to 49 millimeters long, collected by Miss Susana G. Nonato from fishponds in Dagupan, Pangasinan Province, Luzon, and kept in the ichthyological collection of the Division of Fisheries, Department of Agriculture and Commerce, Manila.

Nonatoæ after the collector.

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2. KOUMANS, F. P. A preliminary revision of the genera of the gobioid fishes with united ventral fins (1931) 1–174.
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ILLUSTRATIONS

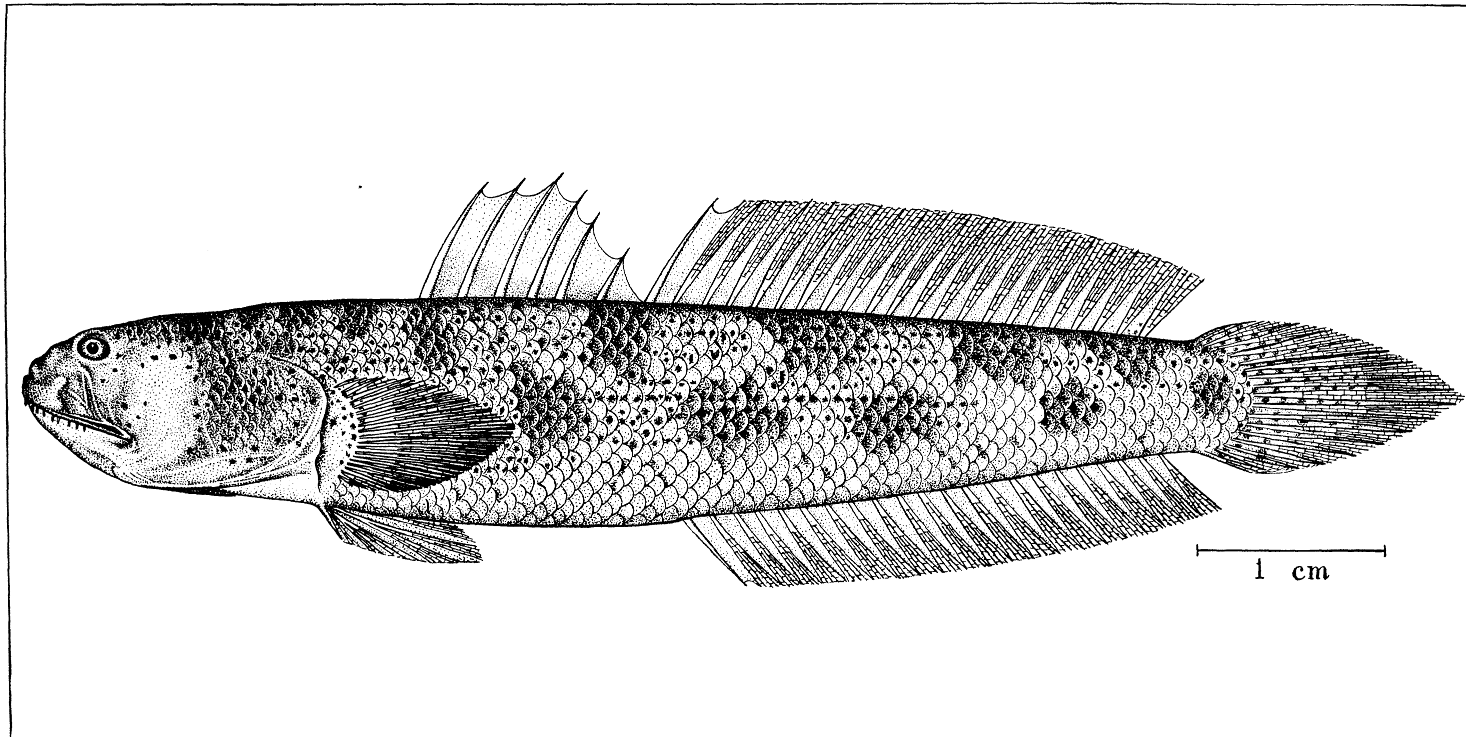

PLATE 1. APOCRYPTODON LOMBOYI SP. NOV.

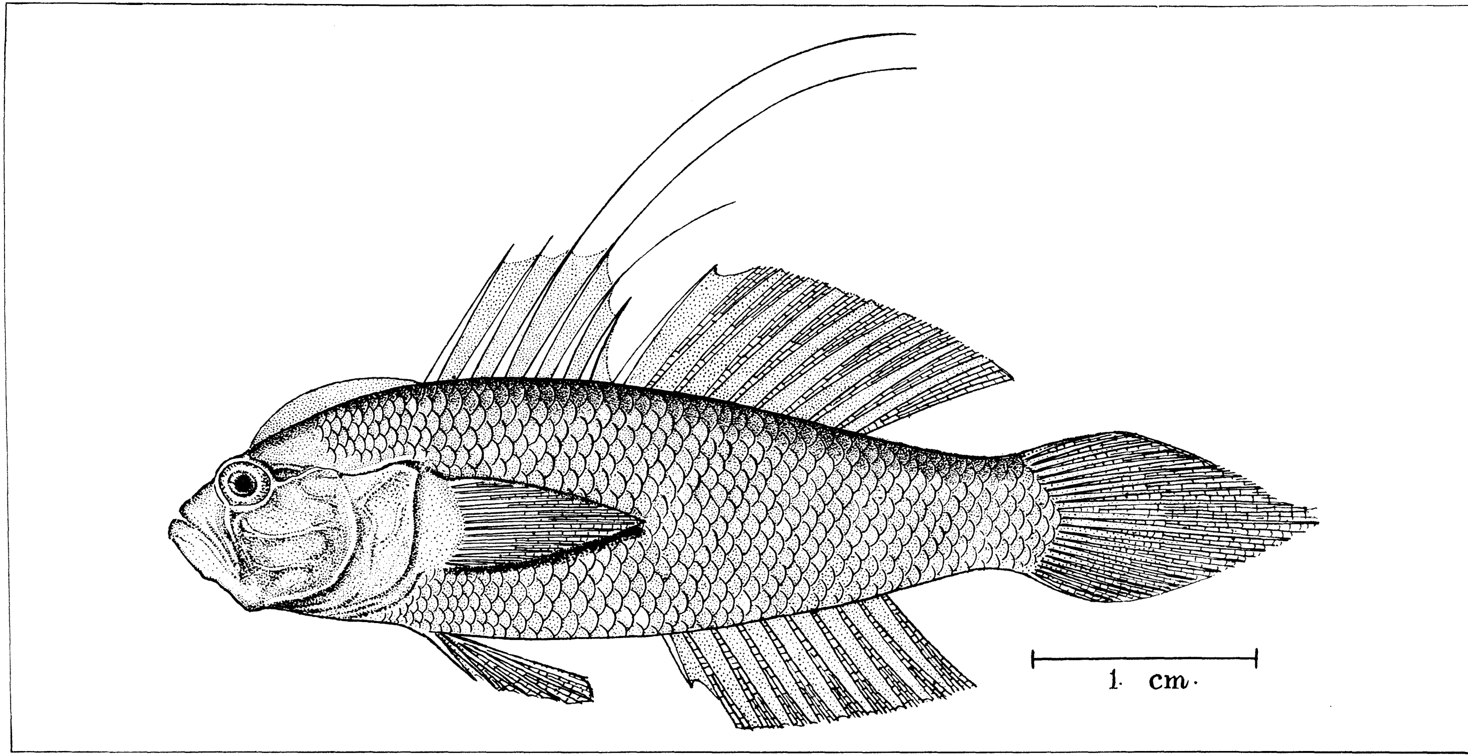

PLATE 2. LOPHOGOBIUS NONATOÆ SP. NOV.

HELMINTH PARASITES OF THE SNAKES OF BURMA, I

TREMATODA

By R. C. Chatterji

Of the Helminthological Institute, University of Rangoon, Burma

FIVE TEXT FIGURES

Investigation of the helminth fauna of the snakes of Burma during the period of the author's connection with the Helminthological Institute of the University of Rangoon, from June, 1930 to December, 1938, has yielded a large number of helminths from various locations in the host. Trematodes have been obtained from the intestine, gall bladder, and bile ducts; adult cestodes from the intestine; free larval forms from the body wall and mesentery; and encysted larvæ from the intestinal wall. Nematodes were obtained from the œsophagus, stomach, intestine, and rectum. Acanthocephala were found only rarely, and invariably as cysts on the intestinal wall, and pentastomids in the lungs. Examination of the heart, liver, kidney, ureter, and oviduct were without result. A total of 212 snakes were examined during this period. The snakes, except the pythons, were obtained either from Rangoon and suburbs or from Thandaung, a town in the Shan plateau, situated at an elevation of approximately 4,500 feet above sea level. The snakes from Rangoon and suburbs caught alive or dead were dissected either by Professor Meggitt or by his junior staff, and those from Thandaung have been dissected exclusively by Professor Meggitt. The author is extremely grateful to Professor Meggitt for the facilities afforded him for study and identification of some of these snakes, and the collection of parasites from them. Forty-one species of snakes belonging to different families have been dissected; Table 1 gives a list of the species dissected and the number found infected.

The trematode parasites of snakes from Burma have already been described by Bhalerao and Gogate in various publications; the present report is intended to throw light on important controversial points recently raised by workers in India and abroad, in connection with the structure and classification of these worms.

An account of two new species of parasites is also included. The author wishes to express his gratitude to Dr. G. D. Bhalerao for the loan of the type slide of *Styphlodora nicolli,* which has facilitated the study of the new species of *Styphlodora* here described.

TABLE 1.—*Species of snakes dissected and number found infected.*

Host.	Number dissected.	Number infected.
Amblycephalus carinatus (Boie, 1828)	1	1
Boiga cyanea (Dumeril and Bibron, 1854)	2	2
Boiga multimaculata (Boie, 1827)	6	3
Bungarus candidus (Linnæus, 1758)	2	2
Bungarus candidus multicinctus (Blyth, 1861)	1	1
Bungarus fasciatus (Schneider, 1801)	3	2
Cerberus rynchops (Schneider, 1799)	4	0
Chrysopelea ornata (Shaw, 1802)	6	5
Dryocalamus davisonii (Blanford, 1878)	2	0
Elaphe radiata (Schlegel, 1837)	4	4
Enhydris enhydris (Schneider, 1799)	25	22
Homalopsis buccata (Linnæus, 1754)	2	2
Lycodon aulicus (Linnæus, 1758)	27	17 [a]
Lycodon jara (Shaw, 1802)	1	1
Lycodon travancoricus (Beddome, 1870)	1	1
Naja hannah (Cantor, 1836)	1	1
Naja naja (Linnæus, 1758)	4	2
Natrix chrysarga (Schlegel, 1837)	1	1
Natrix himalayanus (Günther, 1858)	1	0
Natrix parallelus (Anderson, 1879)	9	9
Natrix piscator (Schneider, 1799)	17	14
Natrix punctulata (Günther, 1858)	1	1
Natrix stolata (Linnæus, 1758)	10	7
Oligodon albocincta (Cantor, 1839)	1	1
Oligodon arnensis (Shaw, 1802)	1	1
Oligodon cruentatus (Günther, 1868)	4	4
Oligodon cyclurus (Cantor, 1839)	15	7
Oligodon violaceus (Cantor, 1839)	16	4
Passerita prasina (Boie, 1827)	1	1
Psammodynastes pulverulentus (Boie, 1827)	1	1
Ptyas korros (Schlegel, 1837)	8	8
Ptyas mucosus (Linnæus, 1758)	15	14
Python molurus (Linnæus, 1758)	1	1
Python reticulatus (Schneider, 1801)	2	2
Sibynophis collaris (Boulenger, 1893)	1	1
Trimeresurus gramineus (Shaw, 1802)	8	8
Trimeresurus monticola (Gray, 1853)	1	1
Typhlops diardi (Schlegel, 1837)	3	0
Vipera russelli (Shaw, 1797)	2	2
Xenelaphis hexagonatus (Blyth, 1856)	1	0
Xenopeltis unicolor (Reinwardt, 1827)	3	3

[a] Only cysts were found.

Family LEPODERMATIDÆ Odhner, 1911

Subfamily STYPHLOTREMINÆ Beer, 1924

Genus STYPHLODORA Looss, 1899

STYPHLODORA DENTIPHARYNGEATA sp. nov. Text fig. 1.

Three specimens were obtained from a single host. Body moderately long, 3.15 to 3.3 mm, thin, cylindrical, maximum

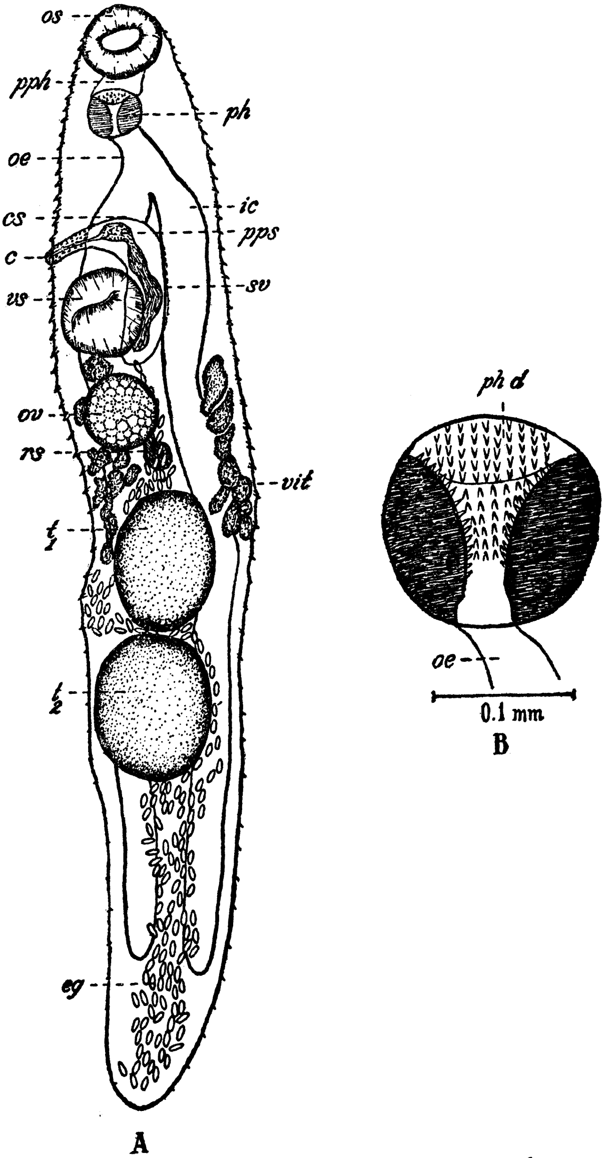

FIG. 1. *Styphlodora dentipharyngeata* sp. nov. *A*, entire; *B*, pharynx, enlarged.

breadth 0.5 to 0.57 mm. Cuticle with stout spines extending throughout entire length of body and arranged in transverse rows, spines in anterior part of body more condensed than in posterior. Oral sucker terminal, subspherical, 0.19 to 0.2 by 0.215 to 0.25 mm. Ventral sucker subspherical, 0.23 to 0.265 by 0.2 to 0.26 mm, at 0.66 to 0.74 mm from anterior end of body, provided with spines. Genital pore median, a little anterior to ventral sucker. Prepharynx approximately 0.03 mm long. Pharynx large, subglobular, 0.1 to 0.14 by 0.12 to 0.15 mm, bearing strong dentitions along its inner margins and leading into a short and wide œsophagus 0.1 to 0.12 mm long. Intestinal cæca ending 0.42 to 0.54 mm from posterior end. Testes large, oval, 0.3 to 0.41 by 0.22 to 0.28 mm and 0.33 to 0.415 by 0.234 to 0.332 mm, respectively, postovarian, entire, oblique, lying one immediately anterior to the other, usually not overlapping. Vas deferens along each side of body, meeting immediately anterior to ovary and posterior to ventral sucker to form a common duct. Cirrus sac 0.35 to 0.43 mm long, crescent-shaped, on dorsal side of ventral sucker, reaching almost to anterior level of ovary. Vesicula seminalis curved, occupying most of space in cirrus sac, followed by a narrow pars prostatica. Cirrus muscular, spiny, often everted. Ovary spherical, 0.2 to 0.22 mm in diameter, lying slightly to right of median line, a little posterior to ventral sucker. Receptaculum seminis pear-shaped, 0.13 to 0.18 long, posterior to ovary. Vitelline glands short, compact, with close-set follicles, extending from posterior margin of ventral sucker to a little posterior to testes. Transverse vitelline ducts from both sides running centrally and joining immediately anterior to receptaculum seminis to form common duct, with no appreciable yolk reservoir. Uterus in the form of undulating descending and ascending coils, running between testes and extending posteriorly as far back as posterior end of body,. provided at its termination with a metraterm approximately 0.4 mm long and extending posteriorly as far as posterior end of ventral sucker. Eggs numerous, 0.04 to 0.044 by 0.0184 to 0.023.

Host.—*Ptyas korros.*
Location.—Intestine.
Locality.—Rangoon.

Bhalerao's (5, p. 194) review of the genus *Styphlodora* does not appear to be too critical. The differentiation of the species on

the basis of "slightly oblique" and "distinctly oblique" testes where the two testes lie close together leaves much to be desired. Neither is the partial or complete separation of the testicular zones a reliable character, as the zones are subject to considerable variation with the contraction and expansion of the specimens during fixation. The three specimens obtained from Rangoon show all varying conditions; in one the testicular zones are well separated by a distance of 0.05 mm, in the other the posterior testis immediately follows the anterior, and in the third the anterior and posterior testes partially overlap. It thus appears that in matter of specific distinction no reliance can be placed on the difference of these two characters. *S. dentipharyngeata* differs from all the species of *Styphlodora* in the presence of dentitions on the inner walls of the pharynx. The presence of a prepharynx in the present form further differentiates it from *S. renalis, S. solitaria,* and *S. persmitus.* Of the remaining species it resembles only *S. nicolli, S. najæ,* and *S. bascaniensis* in having the cirrus sac not contiguous with the ovary. Of these three forms the resemblance is closer to *S. nicolli* than to the other two species, the differences with the other two consisting chiefly in the extent of the cirrus sac and vitellaria. It differs from *S. nicolli,* in addition to difference in the structure of the pharynx, in the more limited extent of the vitellaria and in the shape of the testes and receptaculum seminis.

Subfamily RENIFERINÆ Pratt, 1903

Genus PTYASIORCHIS Mehra, 1937

Allopharynx STROM, Zool. Anz. 79 (1928) 167–172, in part.

Gogate(10) described as *Ostiolum mehrai* a trematode from the gall bladder and bile ducts of *Ptyas korros* and *Ptyas mucosus* in Rangoon. The only important character that differentiates *Ostiolum* from *Pneumonœces* is the absence of the longitudinal extracæcal folds of the uterus. Dollfus(8) on the question of the validity of the genus *Ostiolum* ignored, however, the importance of this character and considered *Ostiolum* synonymous with *Pneumonœces.* Ingles(14) and Caballero and Sokoloff(6) hold the same view as Dollfus, whereas Travassos and Dariba(26) recognize *Ostiolum* as a separate genus comprising the species *O. medioplexus* (Stafford, 1902), *O. complexus* (Seely, 1906), and *O. coloradensis* (Cort, 1917). The study of the ascending extracæcal uterine loops and their varying extent in *Pneumonœces* shows that all conditions may exist, from *P. longiplexus* (Staf-

ford, 1902) where the extracæcal uterine loops extend from the posterior end of the body to near the anterior end, through *P. variegatus* (Rudolphi, 1819), where they reach the ovary and *P. breviplexus* (Stafford, 1902), where they extend up to the region of posterior testis, to *P. uniplexus* (Harwood, 1932), where they are very poorly developed and a short loop is present only on the left side of the body, extending only to the posterior margin of posterior testis. Mehra (1937), like other workers, doubts the validity of *Ostiolum* as a separate genus; but unlike them he thinks the character of the extracæcal uterine loops sufficiently constant to warrant the division of *Pneumonœces* into two subgenera, *Ostiolum* and *Pneumonœces*. In view of the fact that all stages of development of the longitudinal extracæcal folds of the uterus are present in *Pneumonœces* up to a stage where the loop is very poorly developed on only one side of the body, such as in *P. uniplexus*, it does not seem reasonable to stress this point as a character of generic or subgeneric importance, and in the absence of any other character differentiating these genera the author considers that *Ostiolum* should be regarded as a synonym of *Pneumonœces*. However, whether *Ostiolum* is regarded as a synonym or as a subgenus of *Pneumonœces*, Dollfus(8) and Mehra (1937) have rightly shown that *Ostiolum mehrai* does not belong to either, as it differs in a number of important characters, such as the position of the genital opening far behind the pharynx, that is, on the intestinal bifurcation, the presence of a moderately long œsophagus, the presence of a comparatively large ventral sucker near the intestinal bifurcation, the small size of the receptaculum seminis, and the shape and size of the cirrus sac. Added to these is a difference in hosts and habitat: all species of *Pneumonœces* hitherto recorded are exclusively parasitic in the lungs of Anura, whereas the present material is from the gall bladder and bile ducts of colubrid snakes. On account of these differences Mehra created for Gogate's species *O. mehrai* a new genus, *Ptyasiorchis*, with *P. mehrai* as a type species. This new genus has a close affinity with *Xenopharynx* Nicoll, 1912, the points of resemblance being the general topography of the organs, the long intestinal cæca, the small size of the cirrus sac, the position of the genital pore, and the identical nature of the host and habitat. The chief differences between the two are in the structure of the pharynx and the distribution of the vitellaria and uterus. Strom(25) described a trematode, *Xenopharynx* (*Allopharynx*) *amudariensis*,

from the gall bladder of a snake (*Tropidonotus tesselatus*) from Turkestan, which closely resembles *O. mehrai* of Gogate, the affinity being greater than that between *Xenopharynx* (*Allopharynx*) *amudariensis* and the other species of the genus. From other species of *Xenopharynx,* Storm's species exhibits differences in the structure of the pharynx, the position of the genital pore, and the distribution of the vitellaria and uterus. Mehra (1937) has rightly pointed out that Strom's species shows characters which do not permit it to be placed in *Xenopharynx,* and the latter name being quite inapplicable he has erected the genus *Ophiorchis* for its reception. Price(23) has rightly shown that the name *Ophiorchis* Mehra, 1937, is redundant, and the correct procedure is to elevate Strom's subgenus *Allopharynx* to the status of a genus. Thus *Ophiorchis* Mehra, 1937, becomes a synonym of *Allopharynx.* On account of the close similarity between *O. mehrai* Gogate, 1935, the type of the genus *Ptyasiorchis* Mehra, 1937, and *Allopharynx,* Price considers *Ptyasiorchis* Mehra, 1937, as a synonym of *Allopharynx.* Gogate's *O. mehrai,* though allied to Storm's *Allopharynx,* exhibits important differences which do not permit it to be placed in the same genus. It differs from *Allopharynx* in the position of the genital pore, the shape and extent of the cirrus sac, the absence of a metraterm, and the shape of the excretory bladder; and in these respects it resembles *Xenopharynx.* Its differences from *Xenopharynx* are also important, exhibited in the characters of the pharynx, vitallaria, and uterus. It thus appears to the author that *Ptyasiorchis Mehra,* 1937, a genus created for Gogate's *Ostiolum mehrai,* is distinct, and therefore cannot be considered identical with *Allopharynx,* a procedure adopted by Price. Table 2 emphasizes the distinctness of *Ptyasiorchis* Mehra, 1937, and shows its relationship with *Xenopharynx* and *Allopharynx.*

The diagnosis of the genus *Ptyasiorchis* Mehra, 1937, is as follows: Lepodermatidæ, Reniferinæ. Body moderately long and flattened. Oral sucker large, terminal or subterminal. Ventral sucker moderately developed. Prepharynx short. Pharynx large and simple. Œsophagus moderately long. Intestinal cæca ending a little anterior to posterior end of body. Genital pore anterior to ventral sucker, near intestinal bifurcation. Testes postovarian, entire, oblique, anterior testis lying partly or wholly behind middle of body. Cirrus sac weak, subspherical to oval, anterior to ventral sucker or just touching its anterior margin, enclosing a coiled vesicula seminalis and a pars pros-

tatica. Ovary entire, much behind ventral sucker and at some distance anterior to testes, lying on median axis or deflected slightly laterally. Vitellaria in groups of follicles and with conspicuous vitelline ducts, extending from near level of intestinal bifurcation to close to end of intestinal cæca. Uterus voluminous, with descending and ascending transverse coils passing in between testes and extending posteriorly a little beyond intestinal cæca. Metraterm absent. Excretory bladder Y-shaped, with a subterminal pore and a long stem and two pronounced limbs reaching transverse vitelline ducts.

TABLE 2.—*Comparison of Xenopharynx Nicoll, 1912, Allopharynx Strom, 1928, and Ptyasiorchis, 1937.*

Characters.	*Xenopharynx* Nicoll, 1912.	*Allopharynx* Strom, 1928.	*Ptyasiorchis* Mehra, 1937.
Pharynx	Peculiar, contiguous with oral sucker.	Simple, not contiguous with oral sucker.	Simple, not contiguous with oral sucker.
Position of the genital pore.	Median, just over intestinal bifurcation.	Median or slightly lateral, approximately midway between intestinal bifurcation and ventral sucker.	Median, just over intestinal bifurcation.
Cirrus sac	Oval, anterior to ventral sucker.	Cylindrical, slender, extending for some distance or beyond ventral sucker.	Subspherical to oval, anterior to ventral sucker or just touching its anterior margin.
Vitellaria	Profuse in the neck region.	Absent in the neck region.	Absent in the neck region.
Uterus	Not extending towards posterior end of body.	Extending towards posterior end of body.	Extending towards posterior end of body.
Metraterm	Absent	Present	Absent.
Excretory bladder	Y-shaped, with a long stem and two pronounced limbs reaching transverse vitelline ducts.	Imperfectly known. Probably a large vesicle with a slight indentation at the anterior end.	Y-shaped with a long stem and two pronounced limbs reaching transverse vitelline ducts.

Type species.—*Ptyasiorchis mehrai* (Gogate, 1935) Mehra, 1937.

Synonym.—*Ostiolum mehrai* Gogate, 1935.

PTYASIORCHIS MEHRAI (Gogate, 1935). Text fig. 2.

Ostiolum mehrai GOGATE, Rec. Ind. Mus. 37 (1935) 455–458.

Body moderately long [1] and flattened, conical at anterior end but rounded at posterior. Sharp conical cuticular spines extending entire length of body, but distributed sparsely in poste-

[1] Measurements are omitted from this account since they are in agreement with those of Gogate.

rior and dense in anterior part of body. Prepharynx short, inconspicuous in some specimens due to contraction of anterior part of body. Œsophagus moderately long, provided with musculature the extension and contraction of which brings a change in its length. Intestinal cæca with more or less irregular margins, extending a little anterior to posterior end of body. Ventral sucker approximately as large as oral but with less pro-

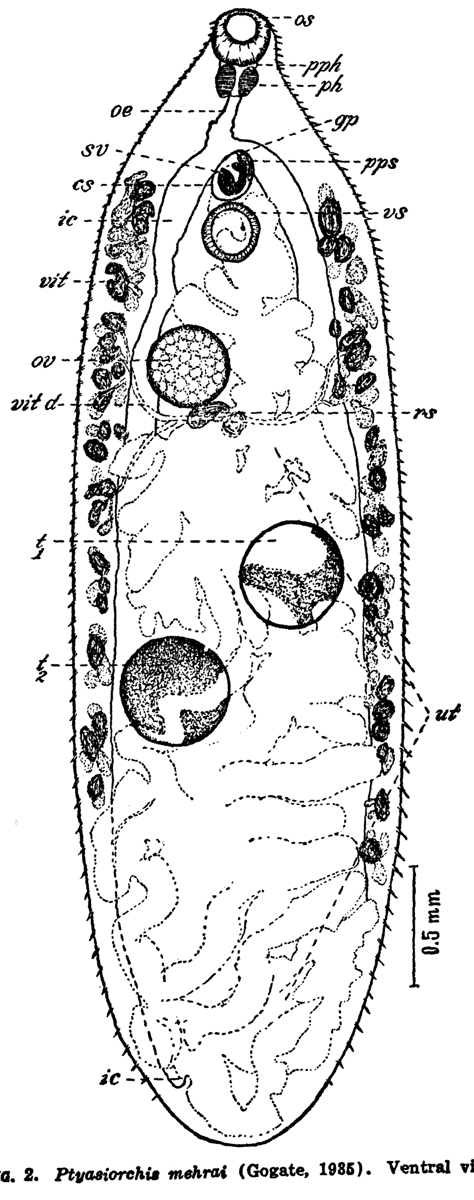

FIG. 2. *Ptyasiorchis mehrai* (Gogate, 1935). Ventral view.

nounced musculature and lying a little posterior to cæcal bifurcation. Genital pore at intestinal bifurcation. Testes and ovary spherical, appearing slightly oval in pressed specimens, the latter organ lying well anterior to the former. Testes entire, oblique, in separate zones, the anterior testis lying partly or wholly posterior to middle of body length and left of the median line. Receptaculum seminis pear-shaped and posterior to ovary. Vas deferentia run anteriorly dorsal to ventral sucker and near posterior margin of this organ unite to form the common vas deferens. Cirrus sac subglobular, weak, lying anterior to ventral sucker or just touching its anterior margin and enclosing for most of its space a much-coiled vesicula seminalis and a small pars prostatica. Ovary spherical, oval in slightly pressed specimens, lying usually a little to the right of the median axis well behind ventral sucker and much anterior to testes. Vitellaria in groups of closely compact follicles extending from level of intestinal bifurcation to near end of intestinal cæca. Longitudinal and transverse vitelline ducts usually conspicuous, the latter meeting posterior to ovary to form the yolk sac. Uterus very voluminous, with descending and ascending coils filled with ova and extending posteriorly to a little beyond termination of intestinal cæca. Metraterm absent. Excretory bladder Y-shaped, with a subterminal pore and a long stem and two pronounced limbs reaching transverse vitelline ducts.

Host.—*Ptyas korros; Ptyas mucosus.*

Location.—Gall bladder and bile ducts.

Locality.—Rangoon.

Family ACANTHOSTOMIDÆ Poche, 1925

Genus ACANTHOSTOMUM Looss, 1899

ACANTHOSTOMUM BURMINIS (Bhalerao, 1926).

Acanthochasmus burminis BHALERAO, Parasitol. 18 (1926) 4–13.

This species was described by Bhalerao(3) from *Natrix piscator* in Rangoon as *Acanthochasmus burminis*. The name *Acanthochasmus* was suggested by Looss in 1900 to replace *Acanthostomum* Looss, 1899, the latter being preoccupied (Insecta, *vide Acanthostoma* Krchbr.). This species has been recovered only from the water snake, and its absence from other snakes suggests that the intermediate host is some aquatic animal.

Host.—*Natrix piscator.*

Location.—Intestine.

Locality.—Rangoon.

Family OMATOBREPHIDÆ Poche, 1925

Genus OMATOBREPHUS Nicoll, 1914

OMATOBREPHUS LOBATUM Mehra, 1928.

Omatobrephus folium THAPAR and ALI (1929).

Gogate (11, p. 455) once obtained two specimens of this parasite from *Ptyas mucosus,* killed in Rangoon. Gogate remarks that his specimens differ from the original forms described by Mehra (1928) from India in "(1) diminutive size; (2) the smaller size of the oral and ventral suckers; (3) the absence of a prepharynx; (4) the comparatively larger ovary; (5) the pear-shaped receptaculum seminis; and (6) the smaller ova". These differences have been considered by him due to individual variation. Whether an assemblage of these characters should be treated as individual variation or specific variation depends on a closer study based on a larger number of specimens, but in the absence of suitable material the author for the present reserves his judgment.

Host.—*Ptyas mucosus.*
Location.—Intestine.
Locality.—Rangoon.

Family DICROCŒLIDÆ Odhner, 1910

Genus MESOCŒLIUM Odhner, 1911

MESOCŒLIUM SOCIALE (Lühe, 1901).

Distomum sociale LÜHE, Zentralbl. Bact. 30 (1901) 166–177.
Mesocoelium meggitti BHALERAO, Ann. & Mag. Nat. Hist. IX 20 (1927) (1927) 611–615.

This form is commonly found heavily parasitising the toad (*Bufo melanostictus* Schneider, 1937) of Rangoon, and has been obtained only once from the present host. In the stomach of this host were found remnants of a large toad (probably *Bufo melanostictus*) which may have conveyed the present infection. The parasite has been recorded from various parts of the world, but the specimen obtained in Burma presents extreme variations in the body size, length of intestinal cæca, and arrangement of the genital organs. The intestinal cæca extend proportionately more posteriorly in smaller specimens than in the larger forms, and they range from approximately three-eighths to two-thirds of the body length; in rare cases the cæca are asymmetrical. Gonads usually spherical but sometimes oval. Testes

are very rarely either triangular, as described and illustrated by Lühe (16, fig. 5) in his original description, or bilobed; they are usually larger than the ovary; very rarely the reverse condition is seen. Right testis usually anterior to left, with ovary on right side of body just posterior to right testis; in a few cases the arrangement is reversed. Vitellaria consisting of a number of oval or round follicles, extending usually from side of oral sucker posteriorly along both sides of body to posterior extremity of intestinal cæca; in exceptional cases they may be sparsely developed and limited to one side of the body or alternatively be so profusely developed that they extend beyond the limit of the intestinal cæca. Ova 0.034 to 0.05 by 0.021 to 0.028 mm (a length of 0.0038 mm as given by Lühe in his original description is a misprint for 0.038). The presence of the variations enumerated above has given rise to the erroneous belief that the present form comprises more than one species. Bhalerao (4, pp. 611–615) described as *M. meggitti* a trematode from the intestine of a lizard, *Mabuia dissimilis* Hallow, 1857, which in all essential characters resembles *M. sociale.* The size of the body, the nature of the cuticle, the ratio of the suckers, the extent of the intestinal cæca, the cirrus sac and the vitellaria, the position of the gonads and of the receptaculum seminis in *M. meggitti,* fall within the limits of the variation in *M. sociale* already discussed. Bhalerao does not mention the presence of a prepharynx, but the material obtained by the author from the same host as that of Bhalerao shows a prepharynx which, however, varies in length in proportion to the amount of contraction of the specimen. Thus it appears to the author that *M. sociale,* usually obtained from *Bufo melanostictus,* is the same as that from *Mabuia dissimilis,* though the systematic positions of the hosts are quite different. Animals which are so unlike may have something in common in their feeding habits, and this probably accounts for the presence of identical parasites in two dissimilar hosts. To corroborate this theory the author has caught both lizards and toads from his own compound and found on examination that both are infected with this parasite. The author has failed to find a clue to the intermediate host; in all probability it will be an insect the remnants of which are mostly found in the rectum of the infected animals. On several occasions ordinary grass blades with stems have also been found in the rectum of the infected toads. Various samples of this grass

were collected from localities where the toads are usually found, but so far no cysts have been obtained that can be ascribed to this species.

Host.—*Ptyas mucosus.*
Location.—Intestines.
Locality.—Rangoon.

Family CYATHOCOTYLIDÆ Poche, 1925

Subfamily PROHEMISTOMINÆ Lutz, 1935

Genus GOGATEA Lutz, 1935

GOGATEA SERPENTIUM (Gogate, 1932). Text fig. 3.

Prohemistomum serpentum GOGATE, Parasitol. 24 (1932) 318–320.

Gogate(10) described this parasite from the intestine of *Natrix piscator* as *Prohemistomum serpentum.* Lutz,[2] in his revision of the family Cyathocotilidæ, created a subfamily Prohemistominæ, pointed out the difference between *Prohemistomum* and Gogate's form, and created a new genus *Gogatea* for the reception of the latter. Szidat[3] accepted Lutz's view and considered *Gogatea* as a genus of Prohemistominæ, but considered the Prohemistominæ of Lutz and Szidat as a supersubfamily (Prohemistomida) and divided it into two subfamilies, Prohemistominæ and Szidatinæ, mainly on the ground of host differentiation, the former being all recorded from birds and mammals and the latter from reptiles. Apart from other considerations, the author can add to the numerous recognized cases of helminths in hosts belonging to groups other than those accepted as usual. In the present collection is a new strigeid, *Mesostephanus burmanicus* sp. nov., from a snake, *Enhydris enhydris,* all other species of this genus being reported from mammals or birds. This occurrence is in direct contradiction to the theory of host specificity as advocated by Dubois. The subfamily Szidatinæ, therefore, which is mainly distinguished from the other on host differentiation, appears to be redundant. Dubois (1938) erected a genus *Szidatia* for a parasite from *Tropidonotus vipe-*

[2] Oberservatœs e consideracœs sobre cyacotylineas e prohemistomineas. Mem. Inst. Oswaldo Cruz. 30 (1935) 157–168.

[3] Szidat, L. Parasiten aus Seeschwalben. 1. Ueber neue Cyathocotyliden aus dem Darm von Sterna hirundo L. und Sterna Paradisea Z. Parasitenk. 8 (1936) 294–299.

rinus, the metacercaria of which was described by Hughes (1929) as *Diplostomulum joyeuxi* Hughes, 1929, and the adult by Joyeux and Baer [4] as *Prohemistomum joyeuxi*. *Szidatia* closely resembles *Gogatea*, even in the character of the vitellaria which Dubois considers to be very different. The arrangement

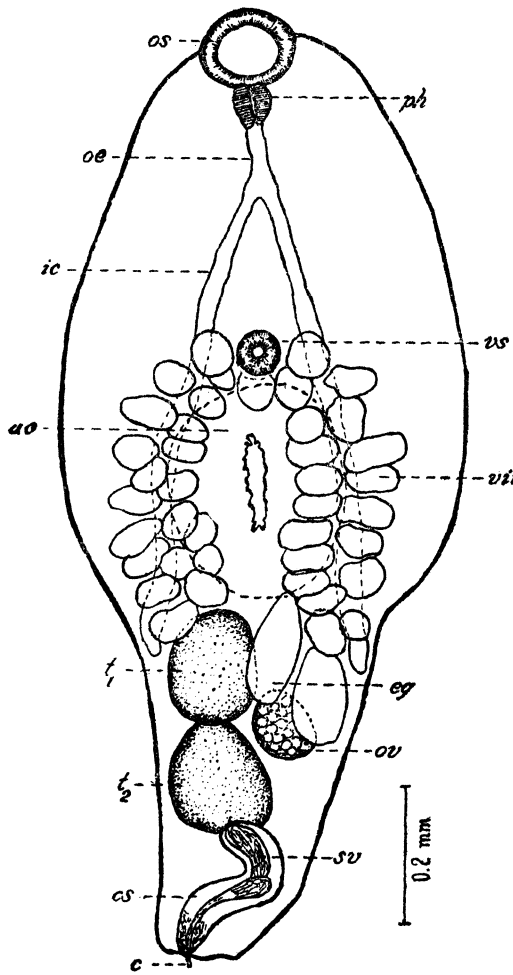

FIG. 8. *Gogatea serpentium* (Gogate, 1931). Ventral view.

of the vitelline glands, which in *Szidatia joyeuxi* extend even laterad to the adhesive organ, is also true for *Gogatea serpentium:* this is clearly seen in fresh and well-extended specimens.

[4] Joyeux, C., and J. G. Baer. Sur un trematode de couleunre. Rev. Suisse Zool. Geneva 41 (1934) 203, 204.

The only difference in the vitellaria is the arrangement of the glands, which in the former are absent from the anterior margin of the adhesive organ, whereas in *G. serpentium* they extend along its anterior margin. This difference has not been emphasized by Dubois, nor is it of generic importance, and in the absence of any other important character the author considers both *Szidatia joyeuxi* and *Gogatea serpentium* as belonging to one and the same genus, the name of which has priority to the name *Gogatea* Lutz, 1935, including both. The foundation of genera on other than morphological characters would render identification impossible.

In a well-extended form body divided into an anterior region, oblong, lamelliform, or sublinguiform, and ventrally concave; posterior cylindrical, lodging sexual glands, cirrus sac, and distal portion of uterus. Gogate and Dubois describe the vitelline glands as confined to the dorsal side of the adhesive organ, but this condition is only true for contracted specimens. In a fully extended form vitellaria divided into large follicles disposed in two rows, arranged in the form of a horseshoe, encircling all margins of adhesive organ except posterior, and extending beyond this organ. Ventral sucker not embedded in adhesive organ as Gogate mentions, but quite conspicuous in fresh and well-extended specimens, and just anterior to adhesive organ. Genital organs well separated from adhesive organ, the condition described by Gogate holding good only for contracted specimens. Posterior portion of body similar to anterior part, showing all varying degrees of contraction. In extended condition testes well separated from one another by ovary, but in contracted state the two testes lying close together and ovary displaced slightly laterally. Intestinal cæca extending beyond adhesive organ, reaching posterior level of anterior testis or ending a little anterior to this level. Cirrus sac with internal vesicula seminalis, a well developed pars prostatica, and a small eversible cirrus. Eggs within uterus 1 or 2.

Host.—Natrix piscator.
Location.—Intestine.
Locality.—Rangoon.

Genus MESOSTEPHANUS Lutz, 1935

MESOSTEPHANUS BURMANICUS sp. nov. Text figs. 4 and 5.

Body scoop-shaped, 0.85 to 1.26 mm long, divided into a broad anterior part, 0.73 to 1 by 0.36 to 0.46 mm, and a short, dorsally

directed appendix, 0.12 to 0.25 by 0.9 to 0.11. Oral sucker subterminal, 0.058 to 0.073 by 0.08 to 0.083 mm. Ventral sucker 0.034 to 0.038 by 0.04 to 0.45, just anterior to adhesive organ (0.18 to 0.22 by 0.19 to 0.24 mm). Pharynx 0.034 to 0.052 by 0.034 to 0.037. Œsophagus relatively long, 0.098 to 0.182. Intestinal cæca slender, terminating a little anterior to junction of

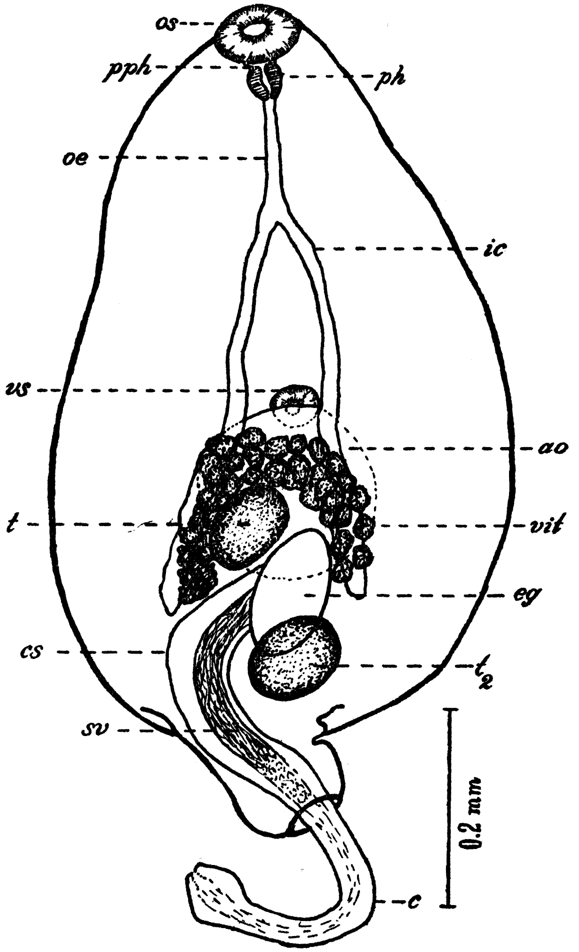

FIG. 4. *Mesostephanus burmanicus* sp. nov. Entire, dorsal view.

anterior and posterior parts of body. Genital pore at posterior end of body, subterminal and directed dorsally. Genital sinus well developed. Cirrus pouch 0.28 to 0.54 by 0.05 to 0.066, extending either to right or left around testes and ovary, its base lying in zone of anterior testis and containing a seminal vesicle,

a long pars prostatica, and an eversible cirrus. Testes oval, oblique, one behind the other, in separate levels; anterior testis 0.09 to 0.095 by 0.04 to 0.06 mm, on left side of body, posterior testis 0.09 to 0.095 by 0.07 to 0.09 mm, on right side of body. Ovary globular, approximately 0.05 to 0.06 mm in diameter, situated between testes. Vitellaria well developed, follicles forming almost a circle around adhesive organ. Uterus short, con-

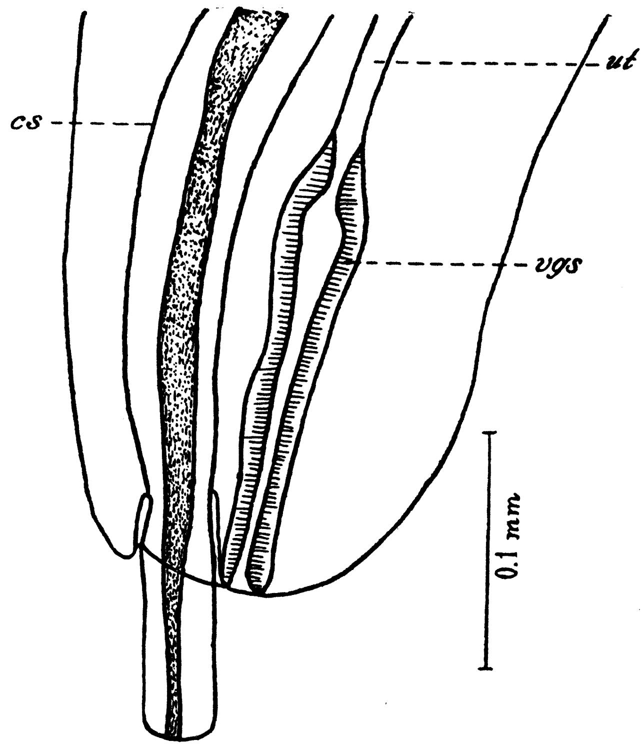

FIG. 5. *Mesostephanus burmanicus* sp. nov. Posterior portion, enlarged, showing vaginal sphincter and cirrus sac deflected.

taining 1 or 2 eggs. Vaginal sphincter well-developed. Eggs 0.098 to 0.14 by 0.073 to 0.096.

Host.—*Enhydris enhydris.*

Location.—Intestine.

Locality.—Rangoon.

Out of four species of *Mesostephanus* the present form resembles *M. appendiculatoides* (Price, 1934) and *M. appendiculatus* (Ciurea, 1916) in having a small pharynx, a ventral sucker smaller than oral, and a few eggs in the uterus. It differs, how-

ever, from both in having a long œophagus instead of a reduced one and a smaller number of eggs (1 or 2) instead of more (2 to 5), besides other minor differences in the size of the body parts. Dubois draws a sharp line between the strigeids of reptiles and those of birds and mammals. The occurrence of the present form in a reptile, when all other species of this genus are found in birds and mammals, is not in conformity with his views. In view of the persistence of the theory that particular helminths are confined to a definite group, and that similar forms in other groups are necessarily different species or genera, it is essential to emphasize that the author could not find in the material here described any morphological character or lack of characters which was not included in a definition of the genus *Mesostephanus*. He has no option therefore but to place it in that genus. In view of the large number (over 100) of specimens found several times in the host it is improbable that it was a pseudoparasite.

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ILLUSTRATIONS

TEXT FIGURES

[Legend: *ao*, adhesive organ; *c*, cirrus; *cs*, cirrus sac; *eg*, egg; *gp*, genital pore; *ic*, intestinal cæca; *œ*, œsophagus; *os*, oral sucker; *ov*, ovary; *ph*, pharynx; *ph d*, pharyngeal dentition; *pph*, prepharynx; *pps*, pars prostatica; *rs*, receptaculum seminis; *sv*, vesicula seminalis; t_1, anterior testis; t_2, posterior testis; *ut*, uterus; *vgs*, vaginal sphincter; *vit*, vitellaria; *vit d*, vitelline duct; *vs*, ventral sucker.]

FIG. 1. *Styphlodora dentipharyngeata* sp. nov. *A*, entire; *B*, pharynx enlarged.

2. *Ptyasiorchis mehrai* (Gogate, 1935). Ventral view.

3. *Gogatea serpentium* (Gogate, 1932). Ventral view.

4. *Mesostephanus burmanicus* sp. nov. Entire, dorsal view.

5. *Mesostephanus burmanicus* sp. nov. Posterior portion enlarged, showing vaginal sphincter and cirrus sac deflected.

THYSANOPTEROLOGICA, IX

By H. Priesner
Of the Ministry of Agriculture, Cairo, Egypt

TWO TEXT FIGURES

1. Genus IRIDOTHRIPS novum

Head heavy, much produced anteriorly, distance between antennal fossæ comparatively great; ocelli small, far apart, interocellar bristles situated at sides of front ocellus; mouth cone large, broadly rounded; maxillary palpi 3-jointed; antennæ 8-jointed, joints 3 and 4 with simple sense cones. Prothorax with one long bristle which is adpressed and directed backward at each fore angle, and two long bristles at each posterior angle; second posteromarginal bristle of pronotum largest; inner anteromarginals short. Bristles on forewing arranged on veins in uninterrupted rows. Abdomen normal, bristles at apex long, dorsals on tergite 9 short. Male brachypterous, female macropterous or brachypterous.

Genotype: *Bregmatothrips iridis* Watson.

Bregmatothrips iridis cannot remain in the genus *Bregmatothrips*, as the fore angles of the pronotum are provided with long bristles which have hitherto escaped notice. These bristles are usually adpressed and directed backward. The insect is closely allied to *Frankliniella*, particularly on account of the dense rows of bristles on the wings and the chætotaxy of the hind margin of the pronotum. It is distinguished from *Frankliniella* by the simple sense cones and the shorter antennæ.

2. Genus DIAPHOROTHRIPS Karny

Key to the subgenera of Diaphorothrips Karny.

a^1. Postocellar bristles long, hairlike; anteocellars small (type, *unguipes* Ka.) .... Subgenus *Diaphorothrips* s. str.

a^2. Postocellar bristles small; anteocellars moderately long (type, *hamipes* Ka.) .... Subgenus *Cnemidothrips* nov.

DIAPHOROTHRIPS (CNEMIDOTHRIPS) CLAVIPES sp. nov.

Female.—Blackish brown to black, antennæ and legs wholly dark, tarsi yellowish gray, or fore tarsi grayish yellow to yellow,

antennal joint 2 and extreme base of 3 somewhat paler yellowish gray; body bristles dark, cephalic spines on genæ black; wings hyaline in basal half, distinctly smoky in apical half or more, longitudinal streak not well developed; fringe paler in basal half of wings than in apical. Major bristles of abdomen yellowish, anal hairs shaded basally.

Head length from eyes 415 μ, including interantennal projection 440 μ, width across eyes about 286 μ, behind eyes 280 μ; very short tempora discernible behind eyes, eyes very moderately large, occupying fore angles of head, somewhat more strongly produced ventrally, their hind margin nearly straight, lateral diameter 102 to 106 μ, cheeks behind eyes about 330 μ long, almost parallel-sided, hardly noticeably convex, somewhat more strongly constricted near base; cheeks with six to eight dark spines, longest spine 35 to 40 μ; mouth cone long and slender, rounded at apex, labrum somewhat protruding; hind ocelli situated in or somewhat in front of middle of eyes, about 83 μ distant; anteocellar bristles moderately long, 39 to 47 μ; postocellars very short, 28 μ; postoculars very long, 256 to 276 μ, pointed, very close (12 to 16 μ) to eyes, situated behind inner margin of latter, head not produced in front; antennæ about 830 μ long, slender. Measurements of joints: 59 (55), 91 (47), 138 (51 to 53), 150 (50), 140 (43), 95 (34), 79 (28), 75 to 79 (20) μ; joint 1 nearly parallel-sided, joint 3 straight laterally, transversely wrinkled at basal third, well provided with setæ as is joint 4, joints 5 to 7 somewhat obliquely truncate apically, joint 8 fusiform, strongly constricted at base; sense cones weak; dorsals, joint 3 with 2 (an outer and an inner), joint 4 with 4, joint 5 with 1 + 1, joint 6 with 1 + 1, joint 7 with 1. Pronotum strongly emarginated at somewhat thickened fore margin, hind margin moderately convex, 208 to 216 μ long, 502 or (with coxæ) 580 μ broad; coxæ triangular; interior anteromarginals of pronotum conspicuous but moderately long (40 μ), anteroangulars about 60 μ long; prothorax with strong, dark, endothoracic median line; posteroangular bristles well 138 μ; coxals about 83 μ; bristles rounded at tip; fore femora enlarged (about 215 μ thick), in middle of exterior margin with an 87-μ-long bristle; fore tibiæ with an inner subapical distinct toothlike process, which protrudes from inner margin of tibia for about 28 to 32 μ; fore tarsi with strong, curved tooth. Mesonotum with faint, transversely netlike, metanotum I with polygonally netlike structure, the latter with two micropores and two small setæ behind them. Wings normal, with 34 or 35

duplicated cilia, basal wing bristles nearly pointed, about 50, 75 to 80, and 83 to 87 μ long, respectively, partly shaded. Legs with only pale preapical hair of tibiæ long. Abdomen slender, segment 1 distinctly netlike, sculptured above; bristles at sides of segments yellowish, longest on segment 6, about 268 μ, on segment 7, 244 μ, on segment 8 much shorter, 118 to 160 μ; bristles on segment 9 long, bristle 2 about 485 μ long; tube long (dorsally 588 μ), decidedly longer than head, breadth at base 162, at tip 60 μ, slightly narrowed towards apex, somewhat more strongly narrowed about apical third; anal hairs weak, about 260 μ long.

Riouw Archipelago, Doerian, September 1933, 1 female, *K. Dammerman No. 45.*

This species differs from *D.* (*C.*) *hamipes* Karny by its larger size, the stronger lateral spines, the strongly shaded wings in their apical half, and especially by the longer and slenderer, wholly dark antennæ; in *hamipes* joints 3 and 4 of the antennæ are 87(43) and 95(46) μ long (broad), respectively. I have also seen *D. hamipes* from Sumatra (Medan, May 15, 1922) where it was collected by L. Fulmek in dry pods of *Cæsalpinia pulcherrima.*

3. Genus MYOPOTHRIPS novum [1]

Head short, a little longer than broad, cheeks strongly convex; eyes large, oval; antennæ 8-jointed, moderately long, joint 8 broad at base; mouth cone short, moderately broadly rounded, middle of prosternum little surpassing, labrum bluntly pointed; one pair of short postocular bristles present; surface of vertex not reticulated. Pronotum little shorter than head; fore femora of female enlarged, fore tibiæ interiorly at apex with a stout, hooklike tooth; fore tarsi short, toothless, but with well-developed claw; anteromarginal bristles of pronotum small, posteroangulars long, pointed. Wings broad, not narrowed, with duplicated cilia. Tube normal, about as long as head, bristles on segment 9 shorter than tube.

Genotype: *M. symplocobius* sp. nov.

This genus is certainly more closely allied to *Smerinthothrips* and *Teuchothrips* than to *Diaphorothrips.* The armature of the forelegs is distinctive.

MYOPOTHRIPS SYMPLOCOBIUS sp. nov.

Female.—Black, fore femora paler (brownish yellow) apically, fore tibiæ brownish yellow, shaded at exterior margin, all tarsi yellow, scarcely or but slightly shaded; antennal joint

1 dark, joint 2 dark only at extreme base and at interior margin, otherwise yellow or ochreous, joints 3 to 5 clear yellow, joint 6 yellow, shaded at apical margin, joints 7 and 8 dark, joint 7 somewhat paler basally (brownish yellow); all prominent bristles of body dark; wings shaded throughout length with scarcely noticeable median longitudinal darkening.

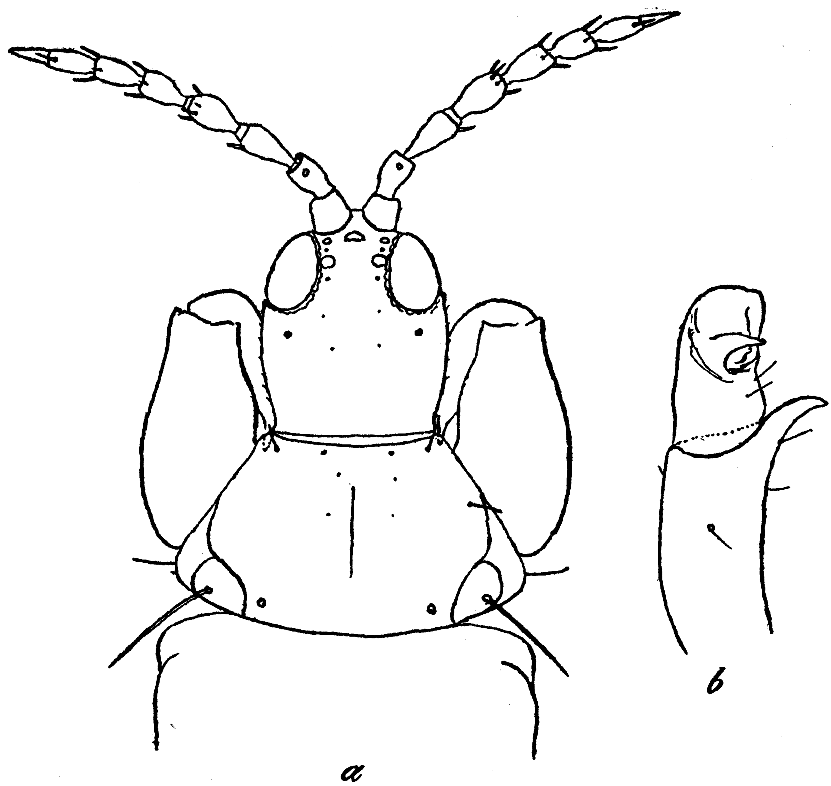

FIG. 1. *Myopothrips symblocobius* gen. et. sp. nov. *a*, female; *b*, apex of fore tibia and tarsus of female, viewed from below.

Head length from eyes 236 μ (including interantennal projection 264 μ), breadth behind middle 217 to 220 μ, much narrower across eyes; cheeks evenly and strongly convex, constricted posteriorly; eyes large, oval, lateral diameter 87 to 91 μ, dorsal (longest) diameter 99 to 102 μ, evenly rounded at hind margin, somewhat shorter ventrally than dorsally; hind ocelli situated in front of a line drawn across middle of eyes and attached to them; one microseta in front of, and behind, hind

1 δηύωῳ = Spur.

ocelli; pores of postocular bristles 24 μ from eyes, 28 μ from cheeks, bristles directed upward and most likely short and thick; head rugose, its sculpture consisting of cross wrinkles, set with fine microsetæ; mouth cone as indicated above; a small pale dot at sides of front ocellus. Length of antennæ 433 to 450 μ; measurements of joints: 43 to 47 (base, 45; tip, 35) 59 (35 or 36), 67 (35 or 36), 65 to 67 (41), 59 (36), 57 (33), 55 to 59 (28), 45 (16 or 17) μ; joint 1 somewhat narrower at tip, joint 2 with large transverse areola before apex, joint 3 somewhat transversely wrinkled basally, abruptly constricted before apex, joint 4 heavy, strongly convex, joint 8 broadest at base, somewhat narrower at base than joint 7 at apex; joint 3 with 1 (exterior) sense cone, joint 4 with $1 + 2^{+1}$ sense cones, joints 5 and 6 with $1 + 1^{+1}$ each, joint 7 with 1 dorsal. Pronotal length 217 to 220 μ, breadth about 345, including coxæ about 398 μ; anteroangular bristles very moderately developed (24 to 28 μ?), anteromarginals minute; posteroangulars long, curved, pointed, 118 to 126 μ; coxal bristle blunt, 47 μ; anterior margin of pronotum almost straight, hind margin convex. Fore femora enlarged, fore tibiæ stout, with an inner, hooklike, yellow tooth at apex; fore tarsi short, unarmed, claw prominent. Length of pterothorax 467, width 450; fore angles of mesothorax rounded. Legs without prominent bristles. Wings broad (above 118 μ in middle), of equal width throughout, somewhat curved, with 15 to 18 duplicated cilia; basal wing bristles pointed, bristle 3, 75 μ long. Abdomen as in many *Smerinthothrips* species with stout, dark (clear at tip) pointed, lateral bristles. Tube somewhat narrowed behind base and again at apical third, length (laterally 256 μ, width across base 102 μ, at apex 43 μ; bristles at sides of segment 7 158 μ, at segment 8 122 μ, segment 9, bristle 1, 146 to 158 μ, bristle 2, 110 to 118 μ, shorter than tube; lateral anal hairs about 158 μ.

Male unknown. Larvæ similar to those of *Smerinthothrips*.

Java, Tjisaroewa, near Buitenzorg, altitude 1,000 meters, July 26, 1925, in leaf gall of *Symplocos javanica* Kurz, 2 females and larvæ (*W. Docters van Leeuwen*).

ANDROTHRIPS KUROSAWAI sp. nov. Text fig. 2.

A large species with very much enlarged fore femora. Brown to ochrous, probably somewhat faded, darkest specimen with tube of darker brown, paler towards apex; middle and hind femora of same color as body, fore femora yellowish at

apex; all tibiæ and tarsi and also joints 3 to 6 of antennæ pale yellow. Forewings faintly shaded with yellow, hind wings with a light gray longitudinal stripe which comes close to hind margin at apical half of wing.

Head longish, cheeks distinctly narrowed towards base, straight or even very slightly concave, somewhat rugose under high magnification, on account of dense transverse striation; eyes large, tempora behind eyes somewhat angular; ocelli large, touching eyes, hind ocelli close to each other; one microseta close to front ocellus, another microseta and a porus exteriorly in front of hind ocelli; two microsetæ, one behind the other, after hind ocelli; mouth cone reaching middle of prosternum, rounded. Antennæ slender, apical joints thin, sense cones tender, two on joint 3, four on 4. Prothorax strongly widened posteriorly, fore and hind margin nearly straight, coxæ rounded, bristles rather pale, long, knobbed, bristles in exterior fore angle very long, interior bristles vestigial. Fore femora very broad, flattened, with distinct, narrow, parallel-sided tooth at base; interior margin of fore femora straight, with several irregular rows of very fine rounded tubercles the size of which does not exceed 4 μ; fore tibiæ curved, with a flat, small plate apically within; fore tarsi with a strong, forwardly directed tooth which emerges from a broad base. Basal wing bristles long, all knobbed; 10 to 15 duplicate cilia. Tube shorter than head; anal hairs long, bristles on segment 9, bristles 1 and 2 knobbed, bristle 3 pointed.

Head, length 288 μ, including interantennal projection, 313 μ; width across eyes, 217 μ; across cheeks behind eyes, 220 μ; lateral diameter of eyes, 102 μ; inner distance of hind ocelli, 26 μ; distance of postocular bristles from eyes, 24 to 26 μ; length of postoculars, 130 to 138 μ; length of antennæ, 519 to 554 μ; antennal joints, 36 (bristle 47), 59(30), 87(41), 95 to 99(35 to 37), 77(26), 67(24), 59(21), 43 to 47(14). Length of pronutum about 233 μ, width without coxæ, 433 μ; including coxæ, 485 μ; anteroangular bristles, 99 μ; laterals, 118 μ; posteroangulars, 130 to 138 μ; width of fore femora, 260; length of basal tooth, 32 to 40. Width of pterothorax, 519 to 536 μ; length of wings, 133 μ; lengths of basal wing bristles, 95, 118, and 158 μ; length of hind tibiæ, 346 μ. Tube, length about 208 μ (dorsal 190); width across base, 97 μ; at apex, 47 μ; lateral anal hairs, 295; bristles on segment 9 (paratype); bristle 1, 197 μ; bristle 2, 205 μ; bristle 3, 205 μ.

Male.—A single male was contained in the same material, which, though much smaller than the females, agrees in the armature of forelegs (femora less stout), and in the color, except that antennal joint 6 is shaded apically and the apices of antennals 5 and 6 are slightly shaded. Double fringe, 9 to 10. Measurements of male (allotype): Head length, 233 μ; including interantennal projection, 256 μ; width across eyes, 181 μ; lateral diameter of eyes, 90 μ; postocular bristles, 95 to 102 μ; antennal joints, 3, 71 (36), 4, 79 (36), 5, 69 μ. Length of pronotum, 197 μ; posteroangular bristles, 95 to 99 μ. Basal wing bristles, 65, 85, 122 to 126; width of pterothorax, about 400. Bristles on segment 9, bristle 1, 197 (blunt); bristle 2 (spine), 39; bristle 3 (pointed), more than 197. Tube length, lateral, 185 μ; dorsal, 173 μ; width across base, 75 μ; at apex, 37 μ; anal hairs, 235 μ.

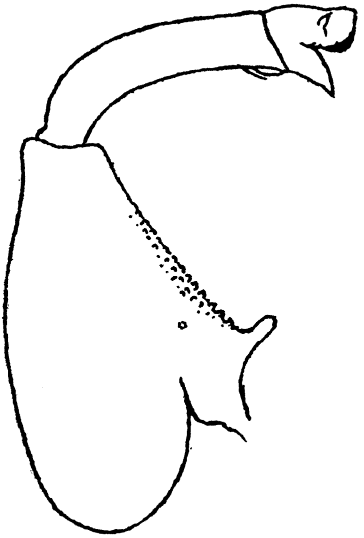

FIG. 2. *Androthrips kurosawai* sp. nov. Foreleg of female.

LUZON, Laguna Province, Los Baños, July 30, 1929, sweeping material, collected by Dr. T. Ishii, communicated to me by Mr. M. Kurosawa to whom I have the pleasure of dedicating the new species.

This insect cannot be easily confused with any of the species hitherto known, as *Androthrips collaris* Karny, *A. ochraceus* Karny, and *A. flavipes* Schm. are distinct by their coloration; *A. ochraceus*, specimens of which I was able to compare, having interior margin of fore femora not set with tubercles, and the whole insect being smaller; *A. obscuratus* Priesner and *A. ramachandrai* Ramakrishna Ayyar have middle and hind tibiæ dark; *A. coimbatorensis* Ramakrishna Ayyar has basal tooth of fore femora much larger and broadly triangular, no tubercles on fore femora, stouter antennæ, and only about five double fringe hairs; *A. flavitibia* Moulton is smaller, has shorter antennæ, and is, after Moulton, allied with *flavipes*, having thus apparently no femoral tubercles; *A. melastomæ* Karny has a series of more conspicuous tubercles (small teeth) at the fore femora within, and is a much smaller insect.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Myopothrips symblocobius* gen. et. sp. nov. *a*, female; *b*, apex of fore tibia and tarsus of female, viewed from below.

2. *Androthrips kurosawai* sp. nov. Foreleg of female.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Your Puppy and How to Train Him. By Huldine V. Beamish. New York, Lee Furman, Inc., 1938. 206 pp., illus. Price, $2.

This book is divided into eighteen interesting chapters dealing with: the question of intelligence, buying a puppy, first lessons, early discipline, civilizing a puppy, free work and preliminary retrieving, early retrieving hints, communal training and signals, relationship with other animals, jumping and advanced work, foods and feeding, the bitch, mating and whelping, rearing puppies, the orphan, ailment in brief, the scourge of terror, and shows and showing, besides an introduction and a conclusion. There are excellent plates illustrating the different tricks a dog can acquire by proper handling and training. Although there are some loose statements, such as "some cow dung or chip droppings—inevitable temptation to puppies, and the surest way to develop worms" and the theories given on the cause of canine hysteria which seem to be obsolete (the disease being now known to be traceable to vitamin B deficiency), the work is a useful contribution. The book is written in a very convenient, attractive and readable form. It is primarily intended for those who wish to give a puppy a break to proper dog education not to become "a mere dog" but to become a well-behaved and useful pet.—L. M. Y.

The Mineral Resources of the Philippines for the Years 1934–1938. Part I. Gold Mines. By William F. Boericke and Nestorio N. Lim. Department of Agriculture and Commerce Technical Bulletin 13. Manila, Bureau of Printing, 1939. 135 pp., illus. Price, ₱1.30, postpaid.

The Bureau of Mines has just published Part I of a new volume entitled "The Mineral Resources of the Philippines, 1934–1938", devoted to a description of the gold mining industry of the Commonwealth. On account of the importance of this industry, the present volume is concerned entirely with the gold mines.

The new volume takes up the development in gold mining since 1934, and appears in the same general form as previous publications by the former Division of Mines, under the Bureau of Science, under the same title. It contains five maps, showing the five principal gold-producing areas in the Philippines with the location of all the principal properties, and several graphs which present the growth of gold production and afford easy comparison between production here and in the United States. It includes descriptions of mining conditions in the Mountain Province, Camarines Norte Province, Masbate Province, Surigao Province, and Central Luzon. Every important producing mine, as well as many semideveloped properties, are described individually from actual field inspections made by the authors, W. F. Boericke and N. N. Lim, mining engineers on the staff of the Bureau of Mines, in coöperation with other Mines officials. Tabulations of gold production of the various producing mines, as well as of the several mining areas, add to the value of the publication.

This is the most comprehensive review of the gold mining industry that has ever been prepared by the Bureau of Mines, and will no doubt be welcomed by mining engineers, investors, and those who wish to obtain authentic information on the present progress of local gold mines.—Q. A. A.

Handbook of Fertilizers; Their Sources, Make-up, Effects and Use. By A. F. Gustafson. New York, Orange Judd publishing Co., 1939. 172 pp., front., illus. Price, $1.75.

The use of natural fertilizers in agriculture has long been known and practiced. However, artificial fertilizers are of comparative recent introduction. The need for adequate knowledge of their sources, compositions, applications, and effects is therefore most vital in the restoration of soil productivity. This is especially true in the old sections of the Philippines, where the soil has been depleted of its fertility on account of its being continuously cropped from generation to generation practically without returning to it, in the form of fertilizers, any of the plant foods removed by the successive crops. Farming today, to be successful, requires that the farmer be in possession of adequate and up-to-date knowledge of fertilizers. The appearance of Doctor Gustafson's "Handbook of fertilizers; their sources, make-up, effects and use", a very practical, clear, concise but complete body of information on this vital factor of present-day farming, is very timely.

The book contains all that is essential to the farmer, gardener, or fertilizer dealer about fertilizers. Moreover, the sequence of its contents is very logical. The book opens with a chapter on plant growth requirements, which leads to a readable discussion on the story and utilization of fertilizers. This chapter is followed by separate chapters on the three more important fertilizer elements; nitrogen, phosphorus, and potassium, and their sources, composition, and manufacture, use, and the effects of each of which are briefly discussed. The chapter is very important, as the visible effects described, especially those on the plant, are the only means by which the average farmer can tell, more or less, the fertilizer needs of his soil. Information on pertinent government requirements for effective factory-mixed fertilizers constitutes another chapter and shows how far the government has gone in protecting the farmer. Another interesting section of the book is a discussion on home-mixed fertilizers, which consists of several formulas and specific directions for mixing the ingredients. The purchase and extent and methods of application of fertilizers, with arguments pro and con in the next chapter, are food for thought.

Owing to the rôle that it plays especially in acid soils, lime is taken up quite in detail. Its functions, sources, applications, and effects are clearly noted. Finally the book closes with a very brief chapter on organic matter, its importance and relation to fertilizer practice, and the methods of maintaining it in the soil.

The book is written in a popular style with hardly a technical term that is not explained and made understandable to the layman. It is especially valuable because of the many useful and instructive tables and illustrations. Farmers, teachers of agriculture, especially of gardening, and fertilizer dealers will find this book very useful and convenient.—A. S. A.

An Outline of General Forestry. By Joseph S. Illick. Third edition, revised and enlarged. New York, Barnes & Noble, Inc., 1939. 297 pp., illus. Price, $1.

This compact book gives a comprehensive and systematic outline of general forestry, with its problems and their solutions. Its thirty-one concise chapters, appropriately divided, impart to both the student of forestry and the layman the outstanding principles of forestry knowledge, and clearly portray "what Forestry is, how it is developed, what it is doing, where it is heading, why it is needed, and what benefits it is bringing to

mankind". One outstanding feature of the book is the effective use of illustrations and graphs which show at a glance comparative figures relative to a particular topic under discussion. At the end of each chapter is a list of selected references for the convenience of the reader who may wish to delve further into the subject dealt with in the chapter.—T. N. R.

The Etiology of Trachoma. By Louis A. Julianelle. New York, The commonwealth fund, 1938. 248 pp., front., illus. Price, $3.25.

This monograph presents a critical and analytical review of the concepts of the etiology of trachoma that have been promulgated up to the present day, and evaluates the results of the research carried on at the laboratory of Washington University and elsewhere. The author first discusses the clinical aspects of trachoma to be sure that his materials are from real cases of trachoma. He then reviews the epidemiology, general conditions in the etiology and infectivity, and the microörganisms associated with trachoma.

After pointing out some defects in the experiments of other investigators, particularly the lack of controls, the small number of trials, the differences in infectivity of the material, and disregard of animal susceptibility, he describes and analyzes carefully the well-controlled, very numerous experiments on the etiologic agent of trachoma performed in his laboratory.

The evidence now available no longer permits an impartial observer to deny that the disease is an infection in its own right without benefit of associated factors. The experiments on the testicular and cerebral passage conducted by the author and his assistants clearly demonstrate that the infectious agent can be recovered in the absence of visible and cultivable organisms. This finding strengthens the viral concept of the etiology of trachoma.

The author summarizes the facts on the etiologic agent of trachoma as shown in his experiments of low infectivity, occasional filterability, marked tissue especialization, ineffectual immunogenic properties, slight propagative capacity, and sensitivity to deleterious agents. The infection it causes is accompanied by inclusion bodies. All these properties suggest the probability that the infectious agent is a virus. What remains to be determined by further investigation is whether the virus is synonymous with the inclusion bodies or its component elements and whether the elementary body may be interpreted as a rickettsia.

The attempts by the author to cultivate the inclusion body in tissue culture have given negative results. It is beginning to appear that viruses and their inclusion bodies may be actually the same thing.

The monograph contains thirteen illustrations, including ten plates. Its bibliography is classified and exhaustive. It is highly recommended for ophthalmologists and will be serviceable to bacteriologists and pathologists.—G. de O.

Modern Methods of Refining Lubricating Oils. By Vladimir A. Kalichevsky. American chemical society monograph series no. 76. New York, Reinhold publishing corporation, 1938. 235 pp., illus. Price, $6.

The use of solvent extraction processes in the commercial refining of lubricating oils is of recent development. These processes, which employ numerous kinds of solvents, are so many that some sort of systematic classification is necessary to facilitate future development along each line. To this end this book has sufficiently served its purpose.

The various topics discussed in this book include methods of evaluating lubricants by certain properties of the refined oil; comparative studies of the old sulphuric acid treatment and the more modern solvent extraction methods of refining; an extensive discussion on the classification of the various solvents used in the purification of lubricants; and general principles of solvent refining processes, including different commercial refining methods.

The book gives a comprehensive discussion of the so-called "additives or oil improvers" such as pourpoint depressants, viscosity index improvers, oiliness carriers, oxidation inhibitors, and many other topics of interest.

Although a great portion of the book is devoted to discussions of general principles underlying the refining of lubricating oils, to those who desire to go into details the book offers quite a good number of references after each chapter. A list of patents is appended to the text.—I. P.

The 1938 Year Book of Physical Therapy. Edited by Richard Kovács. Chicago, The Year Book Publishers, Inc., 1938. 486 pp., illus. Price, $2.50.

This 1938 Year Book of Physical Therapy contains two parts. The first half deals mostly with physical therapy methods, giving the reader an idea of the different kinds of physical energies used together with their respective basic foundations. The

other half deals with the practical applications and therapeutic indications of these physical agents in the treatment of various diseases. As a whole this is a fine reference book not only for the specialist in this line but also for every practitioner who cannot practice medicine and surgery without the valuable aid offered by physical therapy.—P. S. C.

Palæozoic Fishes. By J. A. Moy-Thomas. New York, Chemical publishing Co., Inc., 1939. 149 pp., front., illus. Price, $2.

This book is useful to zoölogists working on comparative anatomy and evolution. To a certain extent it may be useful also to palæontologists interested in Devonian stratigraphy. It traces the changes undergone by fishes in their evolutionary history, beginning with the jawless ostracoderms of the early Ordovician, and winding up with the direct ancestors of the modern teleosts. Every known fish fossil is illustrated and described in detail. The materials are arranged in a natural sequence and discussed in a unique manner so as to bring forth their relationships. The anatomical changes are followed from one species to another, giving notations where one line of development branched off, and where another species is developed.

A good list of references, a glossary, and a detailed index form the last part of the book.—G. L. A.

Practical Identification of Endoparasites for Veterinarians. By John H. Whitlock. Minneapolis, Minnesota, Burgess Publishing Company, 1938. 37 pp., illus. Price, $1.25.

This publication is an attempt at simplifying the complicated natural classification of the endoparasites of domesticated animals. The method of identification followed in this booklet is so simple that an average veterinarian can, with some degree of accuracy, identify specimens of endoparasites. It should serve as an adjunct to the laboratory guide in veterinary helminthology for veterinary students. However, it is of very limited use to veterinary practitioners, contrary to the claim of the author. While this booklet would certainly serve as a valuable guide for government field veterinarians and veterinary meat inspectors in the identification of endoparasites encountered in autopsies and meat inspections, it should not, except in very rare cases, serve as a guide in the accurate diagnosis of parasitic diseases in vivo, because in such cases the veterinary practitioners must depend upon the accurate identification of the ova and larvæ of the different species of endoparasites which are

found in the fæces, urine, vomitus, phlegm, and blood of infested animals.—Z. J.

RECEIVED

BOERICKE, WILLIAM F., and NESTORIO N. LIM. The mineral resources of the Philippines for the years 1934–1938. Part I: Gold mines. Department of Agriculture and Commerce technical bulletin 13. Manila, Bureau of Printing, 1939. 135 pp., illus. Price, ₱1.30, postpaid.

FORBES, RUSSELL. Purchasing for small cities. Chicago, Public administration service, 1939. 22 pp., illus. Price, $0.50.

Hosiery dyeing and finishing. A practical informative reference book for manufacturers and merchandisers of all types of hosiery products, outlining progress and production in this important industry. Compiled by the technical staff of Onyx oil & chemical company, Jersey City, N. J., 1939. 128 pp., illus.

The Journal of Endocrinology, vol. 1, no. 1, June, 1939. London, The Oxford university press. Subscription rate per volume, 30 s., or $6 in U. S. currency.

KURTZ, EARL NICHOLAS. Woman, that eternally supreme question answered. The mystery of truth made startling in its simplicity: "Truth is stranger than fiction". Boston, Meador publishing co., 1938. 437 pp. Price, $2.50.

MAUERSBERGER, HERBERT R., and E. W. K. SCHWARZ. Rayon and staple fiber handbook. A practical reference book for the producer, manufacturer, processor, distributor, drycleaner, launderer, economist and student. 3d enl. ed. New York, Rayon handbook company, 1939. 832 pp., illus. Price, U. S. & Canada, $4.50; Foreign, $5.75.

MIKHAILOV, NICHOLAS. Land of the soviets. A handbook of the U. S. S. R. Translated from the Russian by Nathalie Rothstein. New York, Lee Furman, Inc., 1939. 351 pp., front., illus., maps. Price, $2.50.

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ERRATA

VOLUME 68

Page 10, line 16, *for* symbiform *read* cymbiform.

Page 63, line 26, for *Neiuwenhuisi* read *Nieuwenhuisi.*

Page 64, line 1, *for* Claudopodanthus *read* Cladopodanthus.

Page 74, omit lines 34, 35, and 36 and substitute the following: This species may be distinguished from *Octoblepharum* in the field by the narrower, more brittle leaves. In any event the

Page 79, line 20, *for* 44. *read* 4.

Page 87, line 35 should read: appears in the mountains of Luzon.

Page 91, line 3 from below, for *mollucense* read *moluccense.*

Page 93, line 4 from below, *for* gragarious *read* gregarious.

Page 95, lines 30 and 31, *for* mollucense *read* moluccense.

Page 96, lines 17 and 39, for *mollucense* read *moluccense.*

Page 103, lines 1, 2, 10, and 12, *for* Mercyopsis *read* Merceyopsis.

Page 117, line 16, for *subulata* read *Steerei;* line 18, *for* Barbula subulata Broth. *read* Barbula Steerei Bartr. nom. nov. (Mr. William C. Steere has called my attention to the fact that the name B. subulata Broth. is antedated by B. subulata P. Beauv. I take pleasure in renaming this species for Mr. Steere as indicated above.)

Page 126, line 9, *for* fragil *read* fragile.

Page 181, line 31, for *Micromitrium* read *Macromitrium.*

Page 203, line 29, for *Endotrichiella* read *Endotrichella.*

Page 207, line 24, *for* idenitcal *read* identical.

Page 210, line 13, *for* rectagular *read* rectangular.

Page 262, line 7, *for* laxt *read* lax.

Page 277, line 29, for *Lepidium* read *Lopidium.*

Page 279, line 32, *for* Synoicuos *read* Synoicous.

Page 290, line 2 from below, *for* thing *read* thin.

Page 302, line 1, *for* Dimunitive *read* Diminutive.

Page 309, line 7, *for* Dizon *read* Dixon.

Page 319, line 16, *for* regida *read* rigida.

Page 376, lines 33 and 37, for *Pylasia* read *Pylaisia.*

Page 399, line 13, *for* Sinouse *read* Sinuose.

Page 403, line 22, for *euxydictyon* read *eurydictyon.*

Page 405, line 22, for *refuscens* read *rufescens.*

Page 406, line 28, for *mollucense* read *moluccense.*

Page 407, line 1, for *Meryopsis* read *Merceyopsis;* line 38, for *Barbula subulata* Broth. read *Barbula Steerei* Bartr.

Page 426, line 8, *for* subulata Broth. *read* Steerei Bartr.

VOLUME 70

Page 8, line 14, omit Do.

Page 10, Fig. 1, *for* Antenal grove *read* Antennal groove.

Page 12, line 20, *for* ceiling *read* coiling.

Page 13, line 12 from below, *for* or *read* for.

Page 14, line 4 from below, *for* with antepygidial bristles *read* without antepygidial bristles.

Page 15, line 17, *for* with lateral *read* with none or one lateral.

Page 17, line 7, *for* female *read* male.

Page 22, below Fig. 9 add the following note to the subgenus *Nosopsyllus:* As the paper was completed July 1, 1937, the description of *Nosopsyllus nicanus* Jordan, 1937, which appeared in Nov. Zool. XL: 295–296, is not included in this text.

Page 23, line 2, *for* third *read* fourth; line 4 from below, for laeviceps Wagner *read* laeviceps ellobii Wagner.

Page 24, line 22, *for* two bristles *read* two stout bristles.

Page 27, line 25, *for* apex *read* base.

Page 29, line 18 from below, *for* apical antennal bristles *read* apical bristles.

Page 34, line 13 from below, for *O. silantiewi* read 2. *O. Silantiewi.*

Page 40, line 3, *for* parts *read* pairs; line 11 from below, *for* eye-shaped *read* eye egg-shaped.

Page 42, lines 7 and 8, *for* margin composed of *read* margin of.

Page 45, line 10 from below, for *segments.*—Apex *read segments; male.*—Apex.

page 46, line 23, *for* concave above *read* convex above.

Page 49, line 7 from below, *for* third *read* longest apical bristle of third.

Page 50, line 10, *for* 8*s* *read* 7*s*.

Page 57, line 3 from below, for 8*t* read *F. elata botis* differs from *F. elata elata* as follows: 8*t*.

Page 58, line 6, *for* 7*s* resembling *read* 7*s* of *E. elata botis* resembling.

Page 65, Fig. 63 should be inverted; Fig. 66, the labels *8s* and *8t* should be interchanged.

Page 66, line 6 from below, *for* fourth *read* sixth.

Page 72, line 15, *for* carved *read* caved; line 11, from below, *for* Text figs. 77 and 78, *read* Text figs. 77 and 83.

Page 73, *for* Fig. 78. *Rectofrontia tenella,* female. (After Jordan.) *read* Fig. 83. *Rectofrontia insolita,* female. (After Jordan.).

Page 75, line 1, *for* Text figs. 82 and 83, *read* Text figs. 82 and 78; *for* Fig. 83. *Rectofrontia insolita,* female. (After Jordan.) *read* Fig. 78. *Rectofrontia tenella,* female. (After Jordan.).

Page 77, line 24, *for* Genal composed *read* Genal comb composed.

Page 79, Fig. 89 should be inverted.

Page 82, line 3, *for* male *read* female, not pigmented in male.

Page 91, Fig. 111, for the label *pat* read *par.*

Page 98, line 18 from below, *for* four paratypes *read* four in paratypes.

Page 107, the corresponding line of *Rectofrontia jaonis* (Jord.), in the last column, *for* Do. *read* Shansi; the corresponding line of *Nycteridopsylla galba* Dampf, in the last column, add Soochow after Shanghai.

Page 108, the corresponding line of *Citellus dahuricus mongolicus,* in the second column, for *Diamanus mandarinus* (J. and R.) read *Ceratophyllus tesquorum mongolicus* J. et R.; *add* Mongolia after Shensi in the last column.

Page 111, line 2 from below, last column, *for* Mongolia *read* Shanghai; line 1, from below, last column, *for* Shanghai *read* Mongolia.

Page 112, *add* an asterisk before 15. DAMPF.

Page 113, *add* an asterisk before 31. HICKS; also before 37. IOFF.

Page 114, *add* an asterisk before 54. JORDAN; also before 62. JORDAN.

Page 115, *add* an asterisk before 68. JORDAN; also before 69. JORDAN, before 75. LIU, and before 77. LIU.

Page 116, *add* an asterisk before 100. ROTHSCHILD.

Page 117, *add* an asterisk before 115. WAGNER; also before 118. WAGNER.

INDEX

[New names and new combinations are printed in **boldface.**]

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